



RESEARCH ARTICLE

A Prospective Care with Tobacco Counseling and Medication in a Patient with Oral Submucous Fibrosis – A Case Report

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ABSTRACT

Oral Submucous Fibrosis (OSMF) is one of the most prevalent potentially malignant disorders seen in South east population since ages. The prevalence of Oral Submucous Fibrosis in India is 6.42%. Oral submucous fibrosis is defined as an insidious, chronic disease affecting any part of oral cavity and sometimes the pharynx. It is always associated with fibroelastic changes of Lamina Propria, with epithelial atrophy, leading to stiffness of oral mucosa and causing trismus and inability to eat. Contributing factors includes consumption of spicy food, Gutkha, pan masala, nutritional deficiencies, tobacco chewing and areca nut chewing habits. Despite the extensive amount of research held in this field, its treatment still remains a challenge. In this study, we present our experience in successfully managing OSMF with intralesional injections of dexamethasone 1.5 ml, 1500 IU hyaluronidase and 0.5 ml local anaesthesia on a patient diagnosed with oral submucous fibrosis diagnosed with grade ii OSMF who had a habit of gutkha and tobacco chewing. With proper habit and behaviour counselling, patient was also prescribed medications with capsule S.M. Fibro BID and ointment kenacort TID which was followed by intra-lesional injections once in a week. The remarkable results were seen with increase in mouth opening and symptomatic relief without any side effects.

Keywords: Dexamethasone, Habit counselling, Hyaluronidase, Oral submucous fibrosis, Tobacco.





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INTRODUCTION

Oral submucous fibrosis (OSMF) is a precancerous condition due by inflammatory reaction and progressive fibrosis of the submucosa, seen predominantly in Southeast Asia and Indian subcontinent [1]. It was first described as 'Vidari' by Sushruta in 600 BC which involved progressive contraction of oral cavity, depigmentation of oral tissue and discomfort while consuming food [2]. In 1952, it was termed as 'Atrophica Idiopathica Mucosae Oris' by Schwartz and word 'Submucous Fibrosis of Palate and Pillars' was coined by Joshi in 1953 [3]. In India this condition was first described as diffuse oral submucous fibrosis (Lal 1953) and as submucous fibrosis of the palate & pillars (Joshi 1953) [4]. In 1966, Pindborg defined OSMF as "an insidious chronic disease affecting any part of oral cavity and sometimes pharynx. Although occasionally preceded by and/or associated with vesicle formation, it is always associated with juxta-epithelial inflammatory reaction followed by fibroelastic changes in lamina propria, with epithelial atrophy leading to stiffness of oral mucosa causing trismus and difficulty in eating [5]. Malignant potential rate of OSMF was first estimated to be 7–13% in 1956 by Paymaster [6].

The prevalence of OSMF in India ranges from 0.2–2.3% in males and 1.2–4.6% in females, with age range from 11 to 60 years [7,8,9]. A marked increase in incidence is observed after widespread marketing of commercial tobacco and areca nut products, known as Gutkha¹⁰. Although the etiopathogenesis is multifactorial, areca nut-chewing in any formulation is considered main causative agent. Contributory risk factors suggested includes chewing of smokeless tobacco, high intake of chilies, toxic levels of copper in foodstuffs and masticatories, vitamin deficiencies, and malnutrition resulting in low levels of serum proteins, anaemia and genetic predisposition [11]. The management of OSMF has been discussed previously by several authors^{12,13,14}. The first and foremost treatment plan in OSMF is strict discontinuance of habit with motivation and intense counselling session for educating and creating awareness about the disease and its malignant potential¹⁵. Hyaluronidase acts by breaking down hyaluronic acid which lowers the viscosity of intercellular cement substance. Better results were observed with respect to trismus and fibrosis¹⁶. Several glucocorticoids are used for treatment of OSMF such as short-acting (hydrocortisone), intermediate acting (triamcinolone), and long-acting glucocorticoids (betamethasone and dexamethasone). They act by their anti-inflammatory activity by inhibiting the generation of inflammatory factors and increasing apoptosis of inflammatory cells. Thereby partially relieving patients of their symptoms at an early stage of OSMF¹⁷.

Case Report

A 33-years old male patient driver by profession reported to outpatient department with chief complaint of dirty teeth in upper and lower front region followed by bad breath and difficulty in opening mouth since seven to eight months. Patient had habit of gutka chewing since five years with consumption of 2-4 packets in a day and tobacco chewing since 18 years with consumption of 7-8 times a day. History of cigarette smoking, 1-2 cigarettes per day and habit was stopped 10 years back. On intra-oral examination generalised dental stains were present as shown in Figure A. Burning sensation was present all over the mouth since six-seven month with the score of 7 on visual analogue scale. On inspection mucosa appears to be pale and blanching was seen on right and left buccal mucosa, floor of the mouth & retromolar area extending from the commissural area up to the pterygomandibular raphe as shown in Figure B. All findings of inspection confirmed on palpation. Mouth opening was reduced to 27 mm and tongue protrusion reduced to 36 mm and cheek flexibility reduced by 0.5 mm as shown in Figure C. Fibrous bands were palpated both on right and left buccal mucosa extending from commissural area up to pterygomandibular raphe. Stiffness of buccal mucosa in affected area. Surface was rough and leathery. Considering combination of clinical findings and habit of gutka chewing along with tobacco, a provisional diagnosis of stage II OSMF was given. (Acc. To Nagesh and Bailoor classification). Looking at clinical signs and symptoms of disease, differential diagnosis was given as iron deficiency anaemia, trismus, fibrous ankylosis, plummer-vinson's disease, scleroderma. A required investigatory methods was performed in which complete blood investigation was done and tobacco dependence was measured using fagerstrom nicotine dependence scale both for smoking and smokeless tobacco which had lower level of dependence for smoking form of tobacco with score of 0 and moderate level of dependence for smokeless



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form of tobacco with score of 5. Relevant dental indices were also recorded: Gingival Index by Loe H and Sillness J (1963), Plaque Index by Loe H (1967), Russel Periodontal Index (1956), Modified Lobene stain index (1968). After all investigations final diagnosis was given as stage II OSMF. A comprehensive treatment plan was made, based on concept of conservative management for oral submucous fibrosis. The first step was motivating and counselling patient, so that he quits his habit. During intense counselling session with patient, carcinogenic potential of chewing tobacco and areca nut was explained. The threat of conversion of premalignant condition into malignancy was explained and importance of immediate quitting of habit was emphasised as shown in Figure D. The tobacco counselling initially was started with 5A's (Ask, Assess, Assist, Advice and Arrange). At 15th day patient was explained regarding 5R's of tobacco chewing (Relevance, Risks, Rewards, Roadblocks and Reiterations) and patient was advised to start with 4 D's (Delay, Drink, Deep breath and Do something). Patient was asked to contact us anytime in case if he feels any discomfort or suffers from withdrawal symptoms. Medications like capsule SM fibro (twice a day for 1 month), kenacort ointment (thrice a day for 1 month) and triamcinolone acetonide 0.1% w/w. were initially prescribed for one month. The patient was recommended to perform mouth ballooning, hot water gargles, and muscular stretching exercises. Required dental procedures like oral prophylaxis, restoration of carious teeth and extraction of indicated tooth was performed under local anaesthesia with epinephrine. Patient did not suffer from any withdrawal symptoms. After a month, patient returned for follow-up appointment, and mouth opening had increased by 1 mm, on account of the tissue remodelling achieved by combination of medical therapy and oral physiotherapy that included vitamin B complex capsules, antioxidants and iron supplements. There was also reduction in the burning sensation; though clinically no changes were observed in the status of the diffuse leucoplakic lesion on the left buccal mucosa. For improvement in mouth opening, patient was started on intralesional injections on 30th day for every once in 7 days. Intralesional injection (Dexamethasone – 1.5 ml Hyaluronidase- 1500 IU with 0.5ml of lignocaine HCL injection) was given on right and left buccal mucosa, retromolar area, floor of mouth and soft palate as shown in Figure E. After intralesional injection, first follow-up on 37th day shows increase in mouth opening by 30 mm, tongue protrusion by 37 mm and cheek flexibility was same as before as shown in Figure f. On visual analogue scale the score reduced to 3. On 45th day, second follow-up showed a 1 mm (i.e., 31 mm) improvement in mouth opening and 41mm increase in tongue protrusion as shown in Figure G. As cheek flexibility and VAS remains same. We intended to follow-up the patient at every 15 days interval for two months after treatments but the patient did not show up thereafter.

DISCUSSION

Oral submucous fibrosis, a precancerous condition, reports reveal that it is in existence since time of Sushruta reported by Schwartz in 1962 and by Joshi in 1953 who described its singleton among Indians³. Many trials were conducted but no definitive treatment is available¹⁸. As exact causative factor for OSMF is a matter of conflict, failure to achieve proper treatment for it may be reason for its incomplete regression. Stopping of areca nut chewing is foremost important measure to treat OSMF. Various drugs alone or in combination are used to treat this crippling disease. However, improvement can be obtained passably by intralesional injection of hyaluronidase¹⁹. It was observed that patients receiving hyaluronidase alone showed a quicker improvement in the burning sensation and painful ulceration, although combination of dexamethasone and hyaluronidase gave better long-term results than other regimens. OSMF is a disease with a high degree of incidence. It also carries a significant morbidity rate from oral cancer. The treatment of patients with oral submucous fibrosis depends on the degree of clinical involvement. If the disease is detected at a very early stage, cessation of the habit is sufficient. Most patients with oral submucous fibrosis present with moderate-to-severe disease. Severe oral submucous fibrosis is irreversible. Current modern day medical treatments can make the mouth opening to normal minimum levels of 30 mm mouth opening with proper treatment²⁰. The treatment of OSMF is still not satisfactory. Therefore, further clinical trials with newer modalities and combinations are required to manage this potentially malignant disorder and to prevent its malignant transformation.





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Figure A- visible stains on intraoral examination





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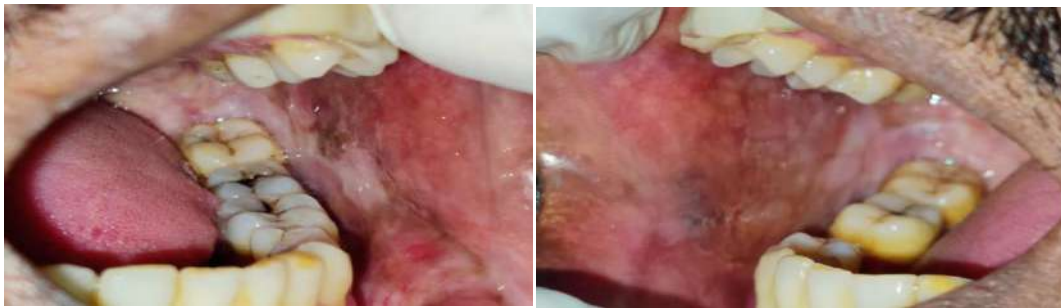


Figure B – palpable fibrous bands present on left and right buccal mucosa extending from commissure to pterygomandibular area

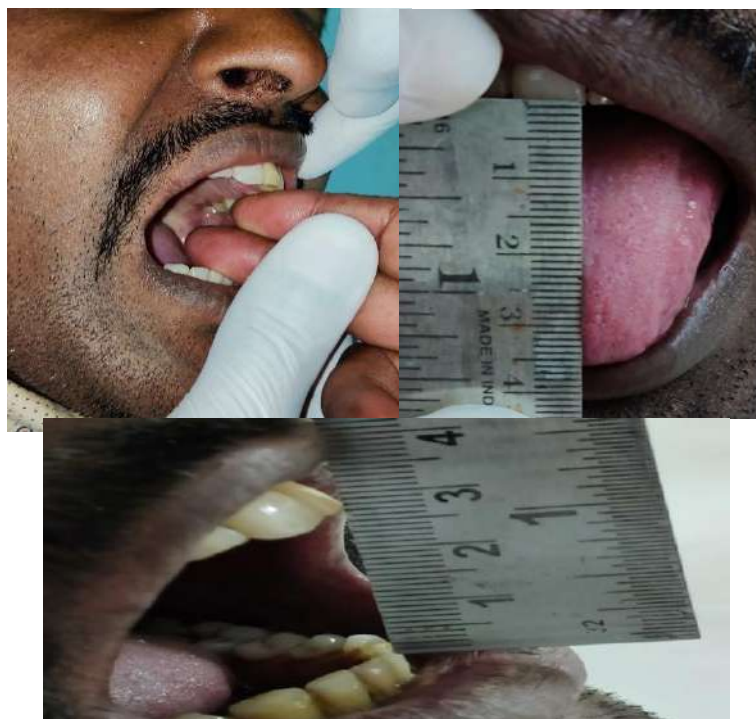


Figure C showing reduced mouth opening of 27mm and tongue protrusion of 36 mm



Figure D- patient was explained regarding various risks and consequences of continuous tobacco chewing





Figure E- Administration of Intralesional injections(Dexamethasone–1.5 ml Hyaluronidase- 1500 IU with 0.5ml of lignocaine HCL injection) on fibrous bands



Figure F – First follow up after administering intralesional injection with an improvement in mouth opening about 30 mm and 37 mm tongue protrusion



Figure G – Second follow up after administering intralesional injection with an improvement in mouth opening about 31 mm and 41 mm tongue protrusion





RESEARCH ARTICLE

An Assessment of Quality of Life In *Uthiravatha Suronitham* (Rheumatoid Arthritis) Patients Reporting at Ayothidoss Pandithar Hospital, National Institute of Siddha – A Cross Sectional Study

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ABSTRACT

Rheumatology refers to inflammatory diseases that affects the skeleton, muscles and joints. Rheumatoid arthritis is an autoimmune disease leads to systemic inflammation. It is characterized by persistant synovitis, and auto antibodies (particularly to citrullinated peptide and rheumatoid factor). Genetic factors attributes about 50% risk for development of rheumatoid arthritis. Rheumatoid arthritis belongs to the systemic connective tissue diseases which is progressive and chronic in nature. It affects peripheral joints mostly. The clinical features were pain (usually at rest), swelling of joints, deformities of joints, morning stiffness for more than one hour, physical activity limitation and quality of life decreased consequently. It was a cross sectional study to assess the Quality of life in *Uthiravatha Suronitham* (Rheumatoid Arthritis). To estimate the quality of life (QOL) in *Uthiravatha suronitham* (Rheumatoid arthritis) patients reporting at OPD of Ayothidoss Pandithar hospital, National Institute of Siddha through Rheumatoid Arthritis Flare Questionnaire (RA-FQ) and to assess the predisposing factors of *Uthiravatha suronitham* with respect to age, gender, chronicity of illness, personal history, occupational history, family history and stress etc. This is a Hospital based cross sectional study, included 100 *Uthiravatha suronitham* patients reported OPD of ayothidoss pandithar hospital were enrolled based on inclusion and exclusion criteria. After obtaining informed consent, the data were collected by using Rheumatoid Arthritis Flare Questionnaire (RA-FQ) and Beck's Depression Inventory form to estimate the quality of life. Data will be collected and analysis will be carried out through proper statistical method. In 100 *Uthiravatha suronitham* patients, overall score is 42.9 in RA-FQ (Maximum 50) questionnaire. In





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beck's depression Inventory showed that 38% patients had Moderate depression and 33% patients had Severe depression.

Keywords: Quality of life, *Uthiravatha suronitham*, Rheumatoid arthritis, Cross sectional study, Siddha.

INTRODUCTION

Rheumatology refers to inflammatory diseases affecting the skeleton muscles, and joints. In medicine, rheumatology is one of the ancient field [1], Rheumatoid arthritis is an autoimmune disease[2] Rheumatoid arthritis is a multisystem disease with various extra articular manifestations[3] which can affect bone and cartilage leading to disability[4]. It is potent enough to cause irreversible joint damage and significant disability[5]. Elevation of ESR and CRP level and antibody to anti- citrullinated protein or rheumatoid factor presence indicates a diagnosis of rheumatoid arthritis[6]. Rheumatoid arthritis is an autoimmune disease leads to systemic inflammation. It is characterised by persistent synovitis, and auto antibodies (particularly to citrullinated peptide and rheumatoid factor). Genetic factors attributes about 50% risk for development of rheumatoid arthritis [7]. The clinical features were pain (usually at rest), swelling of joints, deformities of joints, morning stiffness for more than one hour, physical activity limitation and quality of life decreased consequently [8]. One in three patients with rheumatoid have a chance of becoming disabled. HLA-DR4 and DRI is the most important genetic factors related to Rheumatoid arthritis. These genes share identical regions conferring the risk for Rheumatoid arthritis [9]. Approximately 3 cases per 10,000 population is the annual incidence worldwide. It is reported that the prevalence approximately 1% among 35 and 50 years age group[10]. Over to 14 million people have affected Rheumatoid arthritis up to 2021, by World health organization reported [11]. A cross-sectional study carried out to provide an overview of Quality of life in Uthiravatha Suronitham (Rheumatoid arthritis) patients.

METHODS

It was a hospital based cross sectional study. This study was conducted at OPD of National Institute of Siddha, Tambaram sanatorium, Chennai, Tamil Nadu, India, Total sample size was 100 patients diagnosed as *Uthiravatha Suronitham* (Rheumatoid arthritis) patients reported at OPD of National Institute of Siddha, were selected for this study, with the age group between 30 and 65 years, The study was carried out after obtaining IEC (Institutional ethics committee) approval (IEC NO. NIS/IEC/2021/MP - 8) and was registered in CTRI (the registration number is CTRI/2022/01/039808), [Registered on: 28/01/2022]. The study was conducted from February 2022 to April 2022. After informed about the study and obtained written informed consent, the study participants were asked about the quality of life and functional status and the data were collected by using Rheumatoid Arthritis Flare Questionnaire (RA-FQ) and Beck's Depression Inventory. The data collected from the study were analyzed in SPSS 24.0 software by Microsoft word and Excel method. Selection criteria were 1. Age above 30 years and below 65 years. 2. Male, female and transgender. 3. Known case of *Uthiravatha suronitham* and Patients with sero negative, sero positive RA lab investigations. 4. Patients who are willing to give informed consent. Exclusion criteria for the study were 1. Age below 30 and above 65 years 2. Patient with normal CRP, Anti CCP test results. 3. patient who are not willing to give consent form. 4. Patients defects (Osteoarthritis, psoriatic arthritis, Gout arthritis).

RESULTS AND DISCUSSION

Rheumatoid arthritis is a chronic inflammatory joint disease, which damages cartilages and bones to cause deformities. RA is attributable to genetic factors. It may also affect the cardiovascular, haematological, ocular, vasculitis, pulmonary and neurologic system. In this study, 100 *Uthiravatha suronitham* (rheumatoid arthritis) patients attending Outpatient department of National Institute of siddha were recruited. Among them 14% were male and 86% were female with the





age groups of 30-35(23%), 36-40(11%), 41-45(18%), 46-50(18%), 51-55(16%), 56-60(5%), 61-65(9%). We collected demographic data. Among them 34% were un employed, 30% were unskilled workers, 16% were semi-skilled workers. The prevalence of comorbidities among the patients include hypertension in 16%, diabetes mellitus in 15%. 17% of the patients had family history of *Uthiravatha suronitham* (Rheumatoid arthritis). 82% of people had undergone Ayush treatment, 9% people had undergone Allopathy treatment, 9% people had undergone integrated treatment. sleep pattern was affected in 91% patients. 54% patients had the complaints of Depression, 38% patients had Anxiety. Quality of life of all *Uthiravatha suronitham* patients were assessed using Rheumatoid arthritis Flare Questionnaire (RA-FQ) which includes five domains (Pain, Physical activity, Fatigue, Stiffness, Social events). The RA-FQ score is calculated as the sum of 0-10 (Maximum 50). It is assessed by Mean and standard deviation. The mean scores each domain is Pain 8.73(1.07), Physical activities 8.43(0.98), Fatigue 8.46(1.19), Stiffness 8.93(0.87), Social events 8.35(1.05). The RA-FQ score is calculated by overall range is 42.9(3.80) (Fig. 1) ANOVA test (Table:1) was adopted to analyse the data. This showed a significant association between depression, psychological status and RA-FQ (p value is <0.001).

Sleep (p value is <0.001), family history (p value is <0.014). The quality of life of rheumatoid patients were affected significantly. Bartlett SJ et al reported that in RA-FQ questionnaire, the mean of lot worse was increased with 8.9 points and the mean of lot better with -6.0 points. Minimal worsening had a mean of 4.7 and improvement were associated and -1.8 points in RA-FQ. RA patients had stable scores without any improvement in scores [14]. Imran MY et, al reported that three fourth of the RA patients have depression. Rheumatoid Arthritis disease activity and the level of depression have a strong association. [15]. Beck's Depression Inventory scale was used to assess the mental health, which includes Twenty-one domains (Sad, Discourage, Failure, Satisfaction, Guilty, Punished, Disappointed, Blame, Kill, Cry, Irritation, Irritation, Interest, Decisions, Appearance, Work, Sleep, Tired, Appetite, Weight, Worry, Sex). Each question carries 1 mark, so that total is 63. It was assessed by percentage. 1% had no depression whose score ranges between 1-10, 5% had Mild mood disturbance whose score ranges between 11-16, Borderline clinical depression was found in 12% whose score ranges between 17-20, 38% had Moderate depression whose score ranges between 21-30, 33% had Severe depression whose score ranges between 31-40, 11% had Extreme depression whose score was greater than 40 (Fig.2). From the study results, it was concluded that the quality of life of Rheumatoid Arthritis patients was significantly affected both physically and mentally. Limitation of this study is, it is a single centric study where critically severe patient are relatively less. The major limitations is that there will be recall bias as this study is truly based on the patient's statement.

CONFLICT OF INTEREST

Nil

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Table:1 STATISTICAL ANALYSIS FOR BECK'S DEPRESSION INVENTORY

Variable	No. of sample	RA Score		P-Value	Inference
		Mean	SD		
Level of Depression					
These ups and downs are considered normal	1	26.0	-	P<0.001	Significant
Mild mood disturbance	5	39.2	3.6		
Borderline clinical depression	12	40.8	4.6		
Moderate depression	38	43.4	2.6		
Severe depression	33	43.6	3.4		
Extreme depression	11	44.7	2.3		
Total	100	42.9	3.8		
Psychological Status					
Depression	54	43.4	3.1	P<0.001	Significant
Anxiety	38	43.3	4.0		
Normal	8	37.8	3.6		
Total	100	42.9	3.8		





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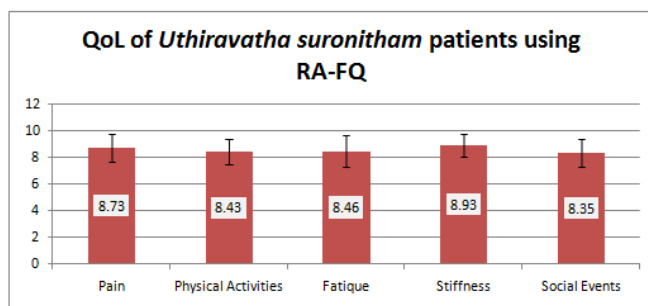


Figure 1. Mean scores of Quality of Life of Uthiravatha suronitham patients using Rheumatoid arthritis Flare Questionnaire (RA-FQ). (n=100)

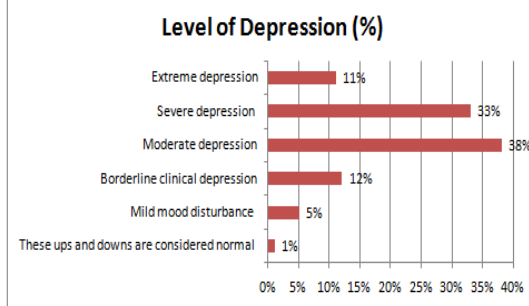


Figure 2. Level of Depression in Uthiravatha suronitham patients using Beck's Depression Inventory scale





Review of *Pugai* – A Siddha Poly Herbal Formulation for *Moolam* (Haemorrhoids)

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ABSTRACT

One of India's historic medical systems is the siddha system. There is a vast array of both internal and external medicines in the Siddha system. Under the mucocutaneous lining of the anal canal's submucosa, hemorrhoids are vascular engorgements of hemorrhoidal plexuses. The most noticeable symptom for many of the patients is bleeding. *Pugai* (Fumigation) is an external therapy in which the medicine is burned directly (or placed into the fire) to produce therapeutic fumes. It has the efficacy to cure both physical and mental diseases. Diseases arising out of the derangement of *Kapham* are easily cured by this treatment. The siddha poly herbal formulation mentioned in *BrahmamuniVaithiyaSoothiram-II* is indicated for *RaththaMoolam*, *SeezhMoolam*. The ingredients in the siddha poly herbal formulation have anti-inflammatory and anti-microbial activity therefore justifying its usage as *Pugai* in the treatment of *Moolam* (Haemorrhoids). Further in vivo and clinical trial will be done for validating the therapeutic effects in future.

Keywords: *Moolam*, *Pugai*, Haemorrhoids, Siddha Poly herbal





INTRODUCTION

Anorectal diseases are the illnesses that affect the rectum and anus. Anorectal diseases are either structural or functional abnormalities of the pelvic floor in patients with symptoms such as difficulty in defecation, faecal incontinence, rectal bleeding, anorectal pain, rectal prolapse.[1]Age ranges 41 to 50 were most frequently impacted, followed by 31 to 40, and men (70.13%) made up the majority of those affected. Two-third patients are males with a male: female ratio of 9:1. The common symptom triad in 72% patients are anal pain, constipation, and difficulty in passing stools, followed by bleeding PR. Distribution of anorectal disorders are: Haemorrhoids (61.7%) > fissure-in-ano (14%) > fistula-in-ano (10.3%).[2]Haemorrhoids may be defined as the vascular engorgement of the haemorrhoidal plexuses in the submucosa of the anal canal. It is classified into internal and external haemorrhoids on the basis of anatomical origin.³ In majority of patients, there are three main primary haemorrhoids. The two masses on the right side and one on the left. It is divided by the superior haemorrhoidal artery. The internal haemorrhoids are classified into 4 grades based on the protrusion of the mass at the anal orifice during defecation.[2]Overall, 68.2% patients were managed surgically. Haemorrhoids are treated with ligature/closed/open hemorrhoidectomy.[3]Saint Yugi classified *Moolanoi* into 21 types. In Siddha, the word "Moolam" refers to the root, or Moolathram. The Siddha method accords Moolatharam the most importance because it is the Kundalini, the center of the body that produces energy. If the early stage is not being taken care of it may lead to complications and need to be corrected with surgery. "Anilapithathondhamalathu-moolamvaraathu"(Anilam-vaatham,Pitha-pitham)-As per saint Theraiyar derangement of Vatham and Pitha humor due to lifestyle changes diet and deeds resulting Moolam.

The main Vathahumor and Pithahumor get affected which cause *Moolanoi*(Haemorrhoids).In *Moolanoi*, increased *Keelvaikanal* stimulates *Vathahumor* these totally stimulate *Pithahumor*, constipation develops due to effects of *Keelvaikanal*. So the symptoms like loss of appetite, emaciation, mental depression, decreased body fluids and blood volume are developed.[4] *Pugai*(Fumigation) is one of the external therapies in Siddha system of medicine. *Pugai* is defined as the method of fumigation in which the medicated fumes are generated by burning the drugs directly or putting the drugs into the fire.⁵ Gram positive staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, and other pathogenic organisms are frequently found infected areas of human body. Gram positive Staphylococcus aureus resides in noses of 30% of the population.[6,7] Since ancient times, naturally occurring plants have played an important role in disinfection. The Siddha poly herbal formulation gives evidence for its therapeutic actions mentioned in the literatures. It has 3 ingredients, all from the plant origin. This review article will help to provide the information about the phytochemical constituents, and pharmacological activity.

MATERIALS AND METHODS

TRIAL DRUG: Moolathuku pugai⁸

PREPARATION OF THE TRIAL DRUG

INGREDIENTS

1. Leaves of *Bambusaarundinaceae* - Moongililai
2. Bark of *Tamarindus indicus* - Puliyampurani
3. Leaves of *Azadirachata indica* - Veppilai

Phytochemical and pharmacological studies of above drugs are mentioned in Table:1

METHOD OF PREPARATION

Both the leaves are burnt in the bark of *Tamarindus indicus* and the fumes are subjected to the *moolam*(*Seezhmoolam*, *Raththamoolam*)





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Pharmacological studies**Antimicrobial activity of *Azadirachata indica***

Maragathavalliet al., studied the antibacterial activity of Neem leaf extract, 0.8 g of each extract was dissolved in DMSO and then varying concentrations of the extracts (200 mg/ml, 100mg/ml, 50mg/ml, 25mg/ml, 12.5mg/ml, and 6.25mg/ml) were obtained. The test organisms used were all human pathogenic organisms of clinical origin. The test organisms were *Staphylococcus aureus*, *Escherichia. coli*, *Pseudomonas aeruginosa*. The ethanol extract had more activity on the test organisms than the other extracting solvents. Suba Priya and Naginiet al., reported that the presence of high concentrations of azadirachtins, quercetin and β -sitosterol in *A. indica* leaves might be responsible for strong antibacterial and antifungal activity.

Anti-inflammatory activity of *Azadirachata indica*

Tirupathiraoannavarapuet al., studied the anti-inflammatory activity of leaf extracts *A. indica* using inhibition of albumin denaturation. The percentage of inhibition of protein denaturation and percentage of membrane stabilization for ethanolic extracts and Diclofenac sodium were done at 50, 100 and 200 μ g/ml. It shows anti-inflammatory activity at concentration 200 μ g/ml shows 57.32% (inhibit protein denaturation) and 46.62%. The results indicate that the ethanolic leaf extracts of *A. indica* possesses anti-inflammatory activity properties.

Anti- inflammatory activity of *Bambusaarundinaceae*

Muniappanet al., 2003 studied the anti-inflammatory effect of the methanol extract of the leaves of *Bambusaarundinaceae* against carrageen-in-induced as well as immunologically induced paw oedema in albino rats and found to be significant when compared to the standard drugs. The combination of methanol extract and phenylbutazone (Non-Steroidal Anti-inflammatory Agent, NSAIA) had been studied and found to be the most potent anti-inflammatory activity experimentally with least toxic (no ulcerogenic) activity. Thus, the combination of herbal product (methanol extract of *Bambusaarundinaceae*) with modern medicine (NSAIA) will produce the best anti-inflammatory drug.

Antimicrobial activity of *Bambusaarundinaceae*

Muhammad Zubair et al., studied the antimicrobial activity of the various organic extracts of *B. arundinaceae* leaves against a panel of food-borne and pathogenic microorganisms were assessed. The plant exhibited considerable antimicrobial activity against most of the bacterial and fungal strains. The results from the disc diffusion method measured in inhibition zone (IZ) followed by measurement of minimum inhibitory concentration (MIC), indicated that *n*-hexane extract showed good inhibitory activity against *E. coli* (IZ= 22.2 mm; MIC = 3.81 mg/mL), *P. multocida*, (IZ = 19.0 mm; MIC = 5.28mg/mL) and *B. subtilis* (IZ=17.0 mm; MIC = 5.62 mg/mL) respectively.

Antimicrobial activity of *Tamarindus indicus*

Ahmed John et al., studied the in vitro antibacterial activity of ethanolic bark extract of *Tamarindus indica* with standard ampicillin against gram positive (*Staphylococcus aureus*, *Bacillus cereus*) and Gram negative (*Klebsiella pneumoniae*, *Escherichia coli*) bacteria. Determination of the inhibition zone by means of well diffusion method shows that bark extract of *Tamarindus indica* exhibited an anti-microbial effect against all tested bacteria.

Anti- inflammatory activity of *Tamarindus indicus*

Shaikh Zohrameena et al., studied the Aqueous ethanol and chloroform extracts from *T. indica* were evaluated for anti-inflammatory properties in mice (ear oedema induced by arachidonic acid) and rats (sub plantar oedema induced by carrageenan) after topical or i.p. administration, respectively. *Tamarindus indica* is known to exert anti-inflammatory and analgesic effects probably by down-regulating the nuclear factor-kappa B (NF-kB) and the p38 mitogen-activated protein kinase pathway.





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DISCUSSION

Pugai (Fumigation) is one of the external therapies in the Siddha system of medicine. This study reveals that the *Pugai* is the effective external treatment procedure to treat hemorrhoids. Fumigation signifies the artificial impregnation of the atmosphere, with the fumes or smoke of any vegetable or aromatic substances. *Pugai* using the burnt Leaves of *Bambusaarundinaceae* - *Moongililia*, Bark of *Tamarindus indicus* - *Puliyampuranileaves* of *Azadirachta indica* are administered in affected parts of the body. The main purpose of this procedure is to reduce microbes and to control infections. Fumigation can be effective in inactivating microbes on environmental surfaces. This promotes effective and fast healing and reduces the pain in hemorrhoids.

CONCLUSION

Moolam (Haemorrhoids) may be efficiently treated using the *Moolathukupugai*. Studies conducted using current research and the aforementioned Siddha literature demonstrate that the ingredients used in *MulathukuPugai* have anti-inflammatory and anti-microbial properties. For further research, the external therapy *Pugai*, should be clinically assessed for treating Hemorrhoids. For better prediction and the advancement of evidence-based medicine in external therapies, the therapy should be accessible in general practice. External therapies for hemorrhoids can be effective, simple, and cost effective OPD procedure and this should be demonstrated with concrete data.

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TABLE:1 INFORMATION ABOUT THE INGREDIENTS

S. No	Botanical name	Tamil name	Parts used	Action	Phytochemistry	Pharmacological studies
1.	<i>Bambusaarundinacea</i>	Moongil	Leaf	Emmenagogue, Anthelmintic	Carbohydrates, Reducing sugars, Proteins & Amino acids, Flavonoids, Saponins, Glycosides, Tannins, Alkaloids and Steroids	Antibacterialactivity, Antiinflammatory,Antiulcer, Protective effects ⁹
2.	<i>Azadirachta indica</i>	Vembu	Leaf	Anthelmintic, Stimulant	Alkaloids, Glycosides, Tannins and Saponins	Anti-Inflammatory,wound healing , anti microbial activity,anti bacterial ¹⁰
3.	<i>Tamarindus indicus</i>	Puli	Bark	Astringent, Tonic	Tannins, Saponins, Glycosides, Peroxidase and Lipids	Antimicrobial activity,Anthelmintic Activity, Anti-inflammatory activity,Analgesic activity, Wound healing activity ¹¹





Isolation, Cultural and Morphological Characteristic Features of *Pythium aphanidermatum*, Causing Rhizome Rot of Turmeric

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ABSTRACT

Turmeric (*Curcuma longa* L.) is one of the most important spices in India. Turmeric belongs to the family Zingiberaceae, considered a "golden spice", "Indian saffron" and "Queen of the kitchen". Among various diseases, Rhizome rot of turmeric is causing more yield losses and causing severe damage to crops. *Pythium aphanidermatum*, A soil borne pathogen is responsible for the rhizome rot of turmeric. 10 *Pythium* samples were isolated from the turmeric growing areas of Tamil Nadu. The samples were examined for Cultural and Morphological characteristics (Color, appearance, margin, colony growth, margin, and sporulation) were observed. ITS region of rDNA amplification with specific ITS1 and ITS4 universal primers produced approximately 600 to 800 bp showing all the samples were confirmed as *P. aphanidermatum*. The sequence of isolate Pa1 was identified as *P. aphanidermatum* through BLAST SEARCH on the NCBI website (www.blast.ncbi.nlm.nih.gov/Blast). The identified sequence was deposited in Gen Bank with the accession number OM979024.

Keywords: Rhizome, *Pythium aphanidermatum*, GenBank, NCBI





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INTRODUCTION

Turmeric (*Curcuma longa* L.) is one of the most important spices in India. Turmeric belongs to the family Zingiberaceae, considered a "golden spice", "Indian saffron" and "Queen of the kitchen". In North India, turmeric is commonly called "Haldi," a word derived from the Sanskrit word *haridra*, and in the south, it is called "manjal," is a part of Indian delicacies, health care as well as rites and rituals since time immemorial (Anoop et al., 2014). The name turmeric derives from the Latin word *terra merita* (meritorious earth), referring to the color of ground turmeric, which resembles a mineral pigment. It is known as *terre me3rite* in French and simply as "yellow root" in many languages in many cultures, its name is based on the Latin word *curcuma*. (Preeti Rathaur et al., 2012). In 2020-2021, the estimated turmeric production is about 2.64 tonnes with a productivity of 6439kg/ ha (2606 kg/acre) (AMIC 2021). The occurrence of rhizome rot disease of turmeric caused by *Pythium aphanidermatum* (Edson) Fitzp. has been recorded in Karnataka, Kerala, Tamilnadu, and Andhra Pradesh states of India. In Tamil Nadu, Erode district occupies the first position in the state in area and second position in productivity next to the Coimbatore district. Turmeric is susceptible to diseases like Rhizome rot, Leaf blotch, Leaf spot, and Leaf blight. Among these, Rhizome rot of turmeric causes severe damage and yield losses. A soil-borne pathogen *Pythium aphanidermatum* is responsible for rhizome rot with symptoms of the disease is drying of the leaves starting from the margin. Water-soaked spots in the collar region, toppling down of infected tillers, rotting of roots and the affected rhizome becoming hollow with only fibrous tissues left behind. rotting of roots and the affected rhizome becoming hollow with only fibrous tissues left behind. It has given up its cultivation owing to the frequent rhizome rot disease that destroyed the crops (Tamaraiselvi et.al 2020). Depending on the intensity of the disease partial to total rotting of rhizomes may occur which would lead to the death of the whole plant. It causes severe yield reduction and reduces the quality of rhizome (Rathiah, 1982). ITS region of rDNA amplification with specific ITS1 and ITS4 universal primers produced approximately 600 to 800 bp showing all the samples were confirmed as *P. aphanidermatum*. The sequence of isolate Pa1 was identified as *P. aphanidermatum* through BLAST SEARCH on the NCBI website. The identified sequence was deposited in GenBank with the accession number OM979024.

MATERIALS AND METHODS

Isolation of *P. aphanidermatum*

The infected turmeric rhizome and pseudo stem samples showing the symptoms of rhizome rot were collected directly from the field from major turmeric growing districts in paper bags and brought to the laboratory. The pathogen was isolated by tissue segment method (Rangaswami and Mahadevan, 1998) on a potato dextrose medium. The infected rhizomes and pseudo stems were washed thoroughly with sterile water, blot dried, and cut into small pieces (5mm²), surface sterilized with 0.1 percent sodium hypochlorite (NaOCl) solution for one minute, then washed with three variations of distilled water to remove traces of sodium hypochlorite and blot dried and then placed in Petri plates containing PDA medium under *in vitro* condition. The plates were incubated at room temperature, 28 ± 2 °C for 5-7 days for the growth of the fungus. The pathogen was identified as *P. aphanidermatum* based on the keys (Plaats-Niterink 1981).

Purification and maintenance of the isolates

After incubation, the pure culture of the fungus was obtained by using a hyphal tip isolation technique. The isolates were sub-cultured frequently under aseptic conditions, with an interval of 10-15 days in PDA slants. The pure culture was aseptically transferred into PDA slants and stored in the refrigerator (4°C) for maintenance and further use. The isolates are designated as Pa1 to Pa10 respectively.

Cultural and morphological characters of various isolates of *P. aphanidermatum*

The cultural and morphological characteristics of the pathogen, like colony color, appearance, margin, and sporulation were studied in the PDA medium. 15 ml sterilized media was poured into the sterile Petri dishes and





allowed to solidify. 9 mm mycelial disc of the pathogen (*P. aphanidermatum*) taken from the peripheral region of 7 days axenic culture with the help of sterile cork borer and placed at the Centre of the Petri plates. Three replications were maintained for each isolate. The inoculated plates were incubated at room temperature (28 ±2°C). Observations on cultural characteristics were recorded 7 days after incubation. The test pathogen was identified and confirmed by comparing them with descriptions given by Plaats Niterink (1981).

Scanning electron microscopy

Actively growing fungal culture was fixed overnight in 0.05M phosphate buffer containing 4% glutaraldehyde at 28°C. On the next day, the fungal mat was washed three times in phosphate buffer and dehydration of the samples was done using ethanol for 15 minutes. The fixed and dehydrated samples were dried with CO₂ for 5 minutes and were fixed on aluminum stubs and sputter-coated with carbon polaron E-500 and immediately observed under a scanning electron microscope at 15 KV. This work was carried out in the Department of Physics, at Annamalai University.

Molecular characterization of *P. aphanidermatum*

DNA extraction

DNA was extracted from one virulent isolate of pathogenic *P. aphanidermatum*. The fungal isolate was grown in 100 ml of PDA broth for 7 days and mycelial mat grown on the Potato dextrose (PD) broth was harvested. The genomic DNA was extracted and purified using the CTAB method (Doyle and Doyle 1990). 100 mg of dried fungal mycelium was ground into fine powder in liquid nitrogen using a mortar and pestle until it formed dry powder. The powder powdered mycelium was transferred to 2.0 ml Eppendorf tubes were incubated in 5 ml, 2 % CTAB extraction buffer [10 mM Tri's base (pH 8.0), 20 mM EDTA (pH 8.0), 1.4 M NaCl, CTAB (2 %), mercaptoethanol (0.1%) and PVP (0.2%)] at 65°C for 30 min. The mixture was added with an equal volume of chloroform: isoamyl alcohol (24:1). The mixture was centrifuged at 10,000 rpm for 10 minutes. The supernatant was transferred to a fresh tube and mixed with an equal volume of ice-cold isopropanol and 5 M NaCl and incubated overnight at -20°C for DNA precipitation. The precipitation was collected and centrifuged at 13000rpm for 10 minutes and the pellet was collected by discarding the supernatant. The pellet was washed with 0.1 M ammonium acetate in 70% ethanol twice and incubated for 15 minutes. The pellet was re suspended in 50 µl of TE buffer (10mM Tris, 1mM EDTA, pH 8.0) (White et al., 1990) and the DNA concentration and purity were determined using a Nanodrop ND1000 spectrophotometer (Nanodrop Technologies Inc). Aliquots of samples were also analysed on a 0.8% agarose gel to check DNA quality.

PCR Amplification

The universal primers ITS-1 and ITS-4 were used to amplify ITS regions of *P. aphanidermatum*

Forward primer: ITS1- F (5' TCC GTA GGT GAA CCT TGC GG 3')

Reverse primer: ITS4- R (5' TCC TCC GCT TAT TGA TAT GC 3')

A single discrete PCR amplicon band of 550 bp was observed when resolved on 1.5% agarose gel. The PCR reaction mixture consisted of 10µl viz., 5 µl of PCR master mix, 1µl of forward primer and 1 µl reverse primer, template DNA 1 µl and 2 µl of sterile water. PCR was performed with an initial denaturation step at 95 °C for 5 min, followed by 40 cycles of amplification with denaturation at 94 °C for 1 min, annealing at 67 °C for 1 min, and extension at 72 °C for 1 min, At the end of the amplification reaction, a final extension step was achieved at 72°C for 10 min. The PCR products were run on 1.2% agarose gels containing 5 mg/ml of ethidium bromide in a TAE (1X) as the running solution. The electrophoretic migration was carried out during 2 h under an 80V. The amplified products were visualized and photographed under UV light (Nzungize et al., 2011). The consensus sequence of the 18SrRNA gene was generated from the forward and reverse sequences. 18S rRNA gene sequence was used to carry out BLAST with the database of NCBI gene bank database. Based on the maximum identity score first ten sequences were selected and aligned using the multiple alignment software program Bio edit version 7,2 ClustalW multiple alignment. The distance matrix was generated and the phylogenetic tree was constructed by using MEGAX. Finally acquiring accession numbers, these sequences were submitted to the NCBI (National Centre for Biotechnology Information) gene bank, USA.





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RESULT AND DISCUSSION

Isolation of samples of *P. aphanidermatum* on turmeric growing areas

A field survey was conducted in 2021 in turmeric growing areas viz., Namagiripettai, Pattanam, Mullukurichi, Metala, Vadugam, Mangalapuram, Alanganatham village in Namakkal district Gangavalli, Valapadi villages in Salem district, and Eragudi in Trichy district. The samples were isolated and designed as Pa₁-Pa₁₀. All the isolates were identified as *P. aphanidermatum*. (Table:1)

Cultural and morphological characters of various isolates of *P. aphanidermatum*

The fungus *P. aphanidermatum* was successfully isolated from the diseased rhizome samples collected from different areas and each isolate was observed for cultural and morphological characteristics. The ten isolates of *P. aphanidermatum* show variation among the cultural characteristics and morphological characteristics viz., colony growth, color, margin, appearance, shape, and sporulation when grown on PDA. These results were recorded and are presented in (Table 2).

Colony color

Based on colony color, the test isolates Pa₁, Pa₅, and Pa₉ showed white spare colonies, whereas Pa₇ and Pa₁₀ showed dull-white colonies, and isolates Pa₂, Pa₃, and Pa₈, showed creamy white colonies, isolates Pa₄, and Pa₆ showed off white colony color (Table.2).

Colony margin, appearance, and shape

The ten isolates are identified based on colony appearance (cottony or fluffy), colony margin (smooth and rough), and colony shape (circular or irregular). Based on colony appearance, the fungal isolates Pa₁, Pa₂, Pa₄, Pa₅, Pa₆, Pa₈, Pa₉, and Pa₁₀ showed a course cottony thread-like appearance while Pa₃ and Pa₇ showed a fluffy appearance. The isolates Pa₁, Pa₃, Pa₄, Pa₇, and Pa₉ showed colonies with a smooth margin while the isolates Pa₂, Pa₅, Pa₆, Pa₈, and Pa₁₀ recorded colonies with a rough margin. The test isolates Pa₁, Pa₂, Pa₄, Pa₆, Pa₇, and Pa₉ showed circular radial growth whereas Pa₃, Pa₅, Pa₈ and Pa₁₀, showed irregular growth. (Table 2).

Sporulation

The isolates were categorized as poor (+), fair (++), good (+++), and excellent (++++ according to their sporulation capacity. The test isolates varied from fair (++) to excellent (++++ sporulation. However, the sporulation count was excellent (++++ in two isolates viz., Pa₁ and Pa₂; good (+++) in five isolates viz., Pa₃, Pa₅, Pa₆, Pa₇, and Pa₁₀ and fair (++) in three isolates viz., Pa₄, Pa₈ and Pa₉. (Table 2).

Morphological and cultural characteristics of *Pythium aphanidermatum*

Hanif et al. (2015) reported that *Pythium* mycelium produces a white color with a fluffy appearance and consists of long, slender hyaline branched hypha. Ashwathi et al. (2017) observed that five isolates of *Pythium* on PDA produced a dense, white cottony mycelial growth with fluffy topography. Each produced aseptate, hyaline mycelium, oogonia terminal, globose, and smooth 20-25 µ diameter. Nandhini (2019) reported that all 10 isolates of *P. aphanidermatum* differed in their mycelial growth and among the isolates Pa₂, Pa₆, and Pa₉ produced cottony creamy white colonies while the other isolates produced white and off-white colonies. Soundarya (2019) isolated two different species of *Pythium* such as *P. aphanidermatum* and *P. debaryanum* from major tobacco-growing tracts of Tamil Nadu and reported the cultural characteristics are differentiated by rapid to moderate, whitish fluffy to sparse raised growth with smooth margins on PDA medium. Subharathinam et al. (2020) isolated *Pythium* spp. In 21 different locations of Tamil Nadu, the cultural characteristics like colony color and colony pattern revealed that all the isolates produced white color with cottony growth. Jayalakshmi et al. (2021) collected infected samples of tomatoes from different parts of Tamil Nadu. Isolated and characterized the pathogen based on their morphological characteristics and they confirmed the isolates as *Pythium aphanidermatum* by observing the hyaline, non-septate mycelium, oospore, and lobed sporangial formation.





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Table 1: Isolate the sample of *P. aphanidermatum* on turmeric growing area Pa*- *Pythium aphanidermatum* isolates

S. No	Isolates	Village	Districts	Pathogen
1.	Pa ₁	Namagiripettai	Namakkal	<i>P. aphanidermatum</i>
2.	Pa ₂	Pattnam	Namakkal	<i>P. aphanidermatum</i>
3.	Pa ₃	Mullukuruchi	Salem	<i>P. aphanidermatum</i>
4.	Pa ₄	Mettala	Namakkal	<i>P. aphanidermatum</i>
5.	Pa ₅	Vadugam	Namakkal	<i>P. aphanidermatum</i>
6.	Pa ₆	Mangalapuram	Namakkal	<i>P. aphanidermatum</i>
7.	Pa ₇	Gangavalli	Salem	<i>P. aphanidermatum</i>
8.	Pa ₈	Valapadi	Salem	<i>P. aphanidermatum</i>
9.	Pa ₉	Eragudi	Trichy	<i>P. aphanidermatum</i>





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10.	Pa ₁₀	Alanganatham	Namakkal	<i>P. aphanidermatum</i>
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Table 2: Morphological and cultural characteristics of *Pythium aphanidermatum*

S. No	Isolates	Colony characters				
		Color	Appearance	Colony growth	Margin	Sporulation
1.	Pa ₁	White sparse	Cottony	Smooth	Circular	++++
2.	Pa ₂	Creamy white	Cottony	Rough	Circular	++++
3.	Pa ₃	Creamy white	Fluffy	Smooth	Irregular	+++
4.	Pa ₄	White	Cottony	Smooth	Circular	++
5.	Pa ₅	White sparse	Cottony	Rough	Irregular	+++
6.	Pa ₆	White	Cottony	Rough	Circular	+++
7.	Pa ₇	Dull White	Fluffy	Smooth	Circular	+++
8.	Pa ₈	Creamy white	Cottony	Rough	Irregular	++
9.	Pa ₉	White sparse	Cottony	Smooth	Circular	++
10.	Pa ₁₀	Dull white	Cottony	Rough	Irregular	+++

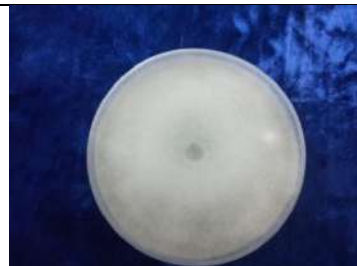
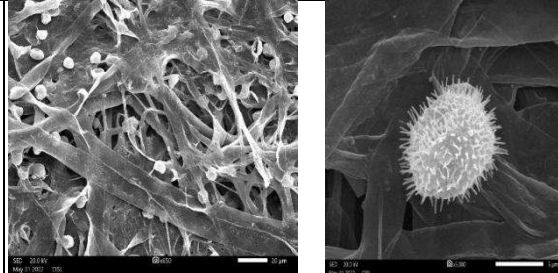
++ = Fair

+++ = Good

++++ = Excellent

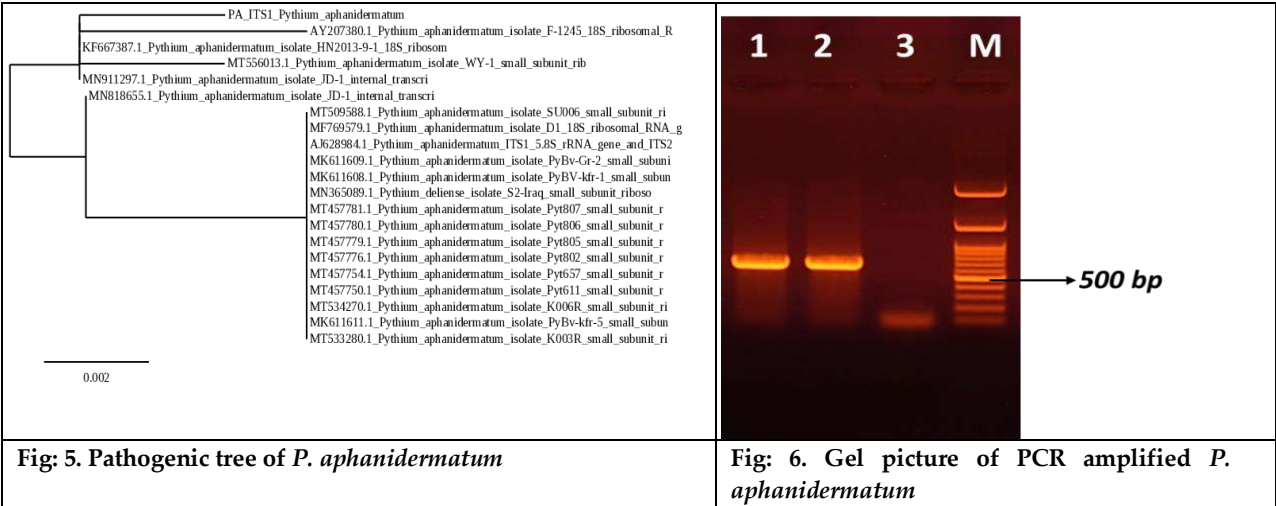


Fig.1: Symptoms of rhizome rot of turmeric

Fig. 2: Axenic culture of *P. aphanidermatum*Fig: 3. Microscopic view of *P. aphanidermatum*Fig: 4. SEM image of *P. aphanidermatum*



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***Curcuma longa*: A Review of Antioxidant, Anxiolytic and Antidepressant Activity**

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ABSTRACT

Curcumin is extracted from the turmeric plant (*Curcuma longa* Linn.) and is widely used as a food additive, culinary and in traditional medicine. Recently, there is growing attention on usage of curcumin to prevent the neurodegenerative diseases. This review summarizes the data available from several studies of curcumin in various phytochemicals role and pharmacological activities such as antioxidant and anxiolytic properties, antidepressant activity of curcumin.

Keywords: Curcumin, Phytochemical, Anxiolytic, Anti-depressive, Antioxidant properties.

INTRODUCTION

Curcuma longa, commonly known as turmeric, is an ancient spice obtained from the rhizomes of *Curcuma longa* and also known as 'Golden Spice of India' turmeric has also been used for centuries in Ayurvedic medicine, which incorporates the medicinal properties of herbs with food. [1] Turmeric is commonly used because the spice is well documented for its medicinal characteristics in India and the Chinese medical system [2]. According to Chattopadhyay et al, (2004) it's widely used in the traditional medicine in India, Pakistan, and Bangladesh because of its several beneficial properties [3]. The plant is cultivated in all parts of India [4] but it also cultivated in southern China, Taiwan, Japan, Burma, and Indonesia as well as throughout the African continent [5].





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Anxiety and depression

The ratio of the global population alive with depression is estimated to be 322 million people 4.4% of the world's population according to a new report, "Depression and other common mental disorders, Global Health Estimates", published by the World Health Organization. The report also includes data on anxiety disorders, which affect more than 260 million people, 3.6% of the world's population [6]. Anxiety is an unpleasant state of internal disturbance that causes nervous behaviors such as fear, anxiety and worry. It can lead to feelings of dread over something unlikely to happen, such as a feeling of imminent death moreover, anxiety disorder is an emotion that is characterized by feelings of worrying thoughts, tension, and physical changes such as increased blood pressure [7]. Anxiety disorders and depression are different; people who develop depression may have had an anxiety disorder earlier in life. [8] Depression is another serious psychological disorder. Depressed people not only have a bad mood, but also sleep or appetite disturbances, significant weight loss or gain, loss of interest or pleasure in daily activities, low energy, inability to concentrate, feelings of worthlessness and repetitive thoughts death or suicide.[9]

Curcuma longa

Turmeric is a perennial herbaceous plant of the Zingiberaceae (ginger) family. It measures up to 1 m in height with a short stem, with long, pointed leaves and funnel-shaped yellow flowers. The important species of genus includes *Cucurma longa*, *Cucurma aromatica*, *Cucurma augustifolia*, and *Cucurma amada*. Turmeric can be grown on almost all types of soils. But well-drained sandy loam soil to clay loam soils rich in organic matter is optimum for production of good crop. The ideal temperature is 20-30°C and preferably at a pH range of 4.5-7.5. [10] It is widely cultivated in Asia, mainly in India and China. Perhaps native to India [11] in our country the leading states of turmeric production are Andhra Pradesh, Orissa, Tamil Nadu, West Bengal, Assam, Bihar and Uttar Pradesh. Other than India, it is cultivated extensively in Bangladesh, Jamaica, Sri Lanka, Taiwan, China, Burma, Indonesia, Fiji and Thailand.[12] Turmeric is a sterile plant and does not produce any seeds. The plant grows 3 to 5 feet tall and dull yellow flowers.[13]. To traditional Ayurvedics practitioners, turmeric was an excellent natural antiseptic, disinfectant, anti-inflammatory and pain reliever, and the plant was often used to aid digestion, improve intestinal flora and treat skin irritation.

Traditional uses of *Curcuma longa* a medicinal plant

India has a rich history of using plants for medicinal purposes. *Curcuma longa* is widely used in the Unani and Siddha system of medicine as a home remedy for various ailments, its origins are for various uses including as a food spice, food pigment and traditional Indian medicine for the treatment of various ailments. . Also it's used in the textile and pharmaceutical industries [14]such as wound healing [15-16], anti-inflammatory [17], antiarthritic [18], analgesic [19], antifebrile [20], antibacterial [21], antiviral [22], antifungal [23], antisensitivity [24], antioxidant [25], neuroprotective [26], antidepressant [27], cardioprotective and lipid-lowering activity [28], anticoagulant [29], antiulcer [30] antidiabetic activity [31], liver protective [32], anticancer [33], antifertility [34] and antitoxin[35]. Turmeric extract and turmeric longa essential oil reduce the growth of various pathogenic bacteria, parasites and fungi. [36]

Traditional uses of *Curcuma longa* culinary

Nowadays it is used as a food, being the main constituent of curry, medicine and colouring [37]. Sometimes in pickles and mustard, turmeric is used to compensate for fading. Turmeric is also used for coloring cheeses, salad dressings, margarine, yoghurts, cakes, biscuits, popcorn, cereals, sauces, etc. Turmeric is also a substitute for mustard in animal feed. Many doctors believe that turmeric is comparable to milk thistle in treating liver disease and improving liver function. [38]. Turmeric is used in cooking for its aroma and color [39]. It is part of curry powder (10-30% turmeric) used to season meat and fish. Vegetarian curry mixes have a lower content of turmeric due to its bitter taste [40]. Turmeric is probably the oldest known cosmetic product, as it was traditionally applied to women's skin. It is believed to reduce facial hair growth, reduce acne, and improve skin tone [41, 42]. Turmeric gel has been reported to improve the appearance of light-damaged skin conditions such as changes in pigmentation, solar elastosis, actinic poikiloderma, solar and actinic freckles, keratosis when applied for a long time, such as six months [43].





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DISCUSSION

Worldwide, more than 10 million people suffer from neurological diseases every year, and this number is expected to increase in the future [44]. About 3.1% of the population aged 70-79 in Western countries has neurodegenerative diseases, while in India the incidence of the disease in individuals of the same age is 0.7%. The difference is mainly due to different lifestyles and eating habits depending on the consumption of different ingredients. [45] In recent years, more and more attention has been paid to traditional medicine. In traditional medicine, many plants have been used to treat neurodegenerative diseases such as Alzheimer's disease (AD) and other memory-related disorders [46].

Phytochemistry of *Curcuma longa*

The phytochemical investigations of aqueous extract, acetone extract, ethanolic extract, chloroform extract and methanolic extract of *Curcuma longa* rhizome commonly using [47]. The components of turmeric are mainly curcumin and are called curcuminoids (diferuloylmethane, demethoxycurcumin and bismethoxycurcumin) [48]. Study shown that tumeric plant had 0.76 % alkaloid, 0.45 % saponin, 1.08 % tannin 0.03 % sterol, 0.82 % phytic acid, 0.40 % flavenoid and 0.08 % phenol , 0.76 % alkaloid [49] and proximal composition turmeric contains 8.92% moisture, 2.85% ash, 4.60 % crude fibre and 6.85 % fat. It also contains 9.40 % crude protein and 67.38 % carbohydrate. [50] The main phenolic compounds present in *C. longa* include demethoxycurcumin and bisdemethoxycurcumin, which are rich in curcumin (main active compound) [51][52]. Quantities of minerals and vitamins in turmeric (per 100 g dry matter) include 200 mg of calcium, 260 mg of phosphorus, 2500 mg of potassium, 47.5 mg of iron, 0.9mg of thiamine (B1), 0.19mg of riboflavin (B2), 4.8mg of niacin (B3), and 50 mg of ascorbic acid [53]. Table-1 shows the Major volatile components in different part of *Curcuma longa*.

Curcuma longa compounds

C. longa contains different curcuminoids, but curcumin was found to be the most active one, first isolated in 1815 [61] (Vogel and Pelletier, 1815), The curcumin structure was first proposed by Polish scientists in 1910 [62]. Although curcumin generally refers to 1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione, the compound is also known as "curcumin I". curcumin is a diferuloylmethane with a crystalline yellow-orange colour, molecular weight of 368.39 g/mol, melting temperature of 183°C, and with the chemical formula C₂₁H₂₀O₆ [63]. There are two additional compounds known as curcumin, which are curcumin II [demethoxycurcumin (DMC), 1-(4-hydroxy-3-methoxyphenyl)-7-(4-hydroxyphenyl)-1,6-heptadiene-3,5-dione] and curcumin III [bisdemethoxycurcumin, (BDMC) 1,7-bis(4-hydroxyphenyl)-1,6-heptadiene-3,5-dione] (Buckingham, 2018) [64]. According to Paulucci et al, (2013) Solvent extraction followed by column chromatography is the most common method used to separate curcumin from turmeric, and several polar and non-polar organic solvents including hexane, ethyl acetate, acetone, methanol, etc. have been used [65].

Essential oils from *Curcuma longa*

There are some variations in this composition, which may depend on genetics, type of raw material (dry or fresh) and plant part, harvest season, geographical conditions, light, and the method used which extracts oil [66]. *C. longa* EO has been shown to inhibit *Mycobacterium smegmatis* [67], *Fusarium verticillioides* [68], *Microsporum gypseum*, *Epidermophyton floccosum*, *Trichophyton mentagrophytes*, *Trichophyton rubrum* [69], *Escherichia coli*, *Candida albicans*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Saccharomyces cerevisiae* [70] Several studies in the literature indicate that *C. longa* EO has various bioactivities such as antimicrobial, repellent, antioxidant, anti-inflammatory and anticancer, antilarvicidal [71]. Table-2 shows the Compounds responsible for the bioactive potential of *C. longa* essential oil.

Pharmacological role of *Curcuma longa*

C. longa is widely recognized as an herbal medicine, having a wide range of pharmacological effects. Table-3 summarizes the turmeric in various pharmacological activities.



**Sunit Nath et al.,****Antioxidant properties of *Curcuma longa***

Oxidative stress (OS) is a condition caused by an imbalance between oxidants and antioxidants in biological systems. The imbalance is caused by excessive levels of reactive oxygen species (ROS) or dysfunction of the antioxidant system [84]. According to Tanvir et al, (2017) it is determined that turmeric ethanol extract has a more significant antioxidant effect than the aqueous turmeric extract that against free radical damage. [85] Pro-oxidant curcumin is a powerful bioprotectant with various pharmacological properties including transition metal ions (Cu and Fe). ROS, such as superoxide anion, hydroxyl radical, singlet oxygen, peroxy nitrite, and nitric oxide, are all successfully neutralized by this treatment. [86] Various in vitro and in vivo studies have been conducted, and the antioxidant potential of curcumin has been recognized to its chemical structure, including carbon-activated protein kinases (MAPK) and pathways involved in nitric oxide synthase (NOS) enzymes synthesis [87,88,89,90] Curcumin has been shown to be an effective oxygen free radical scavenger. Its antioxidant function is like that of vitamins C and E. It can prevent oxidation caused by lipids or hemoglobin. [91]

Anti-depressive role of *Curcuma longa*

Depression is a common chronic, relapsing mental illness that significantly affects quality of life and increases the risk of death. [92] It has been proposed that *Curcuma longa* has anxiolytic and antidepressant properties, in animals, in some preliminary studies, according to YU ZF et al. (2002), aqueous extracts of *Curcuma longa*, administered orally to rats at a dose of 560 mg/kg, were more potent than the reference antidepressant fluoxetine [93]. It has been reported that the antidepressant effect of curcumin is related to the serotonergic system, in which curcumin interacts with 5-HT 1A/1B and 5-HT 2C receptors [94]. Study shown that, mitochondrial dysfunction has historically been associated with various neuropsychiatric disorders, including depression, bipolar disorder and schizophrenia [95] [96] It has been reported that curcumin can protect mitochondria from oxidative damage by reducing intracellular generation of ROS and synchronous attenuation the apoptosis of cortical neurons in mice. [97]

Anxiolytic role of *Curcuma longa*

Anxiety disorder involves a state of increased exaggerated version of the acute stress response and fear [98]. Health repercussions of anxiety are very variable from consistent stress associated with higher risk of cardiovascular and cerebrovascular diseases [99] to physical manifestation such as headaches, uncontrolled trembling and sweating, muscle tension and aches [100]. A study conducted by (Hind Benammi et al, 2014) stated that curcumin extract against experimental lead induced-anxiety in male wistar rats possibly result from modulation of central neuronal monoaminergic neurotransmission, especially serotonin, which has shown a significant reduction of the immunoreactivity within the DRN (dorsal raphe nucleus). [101] Curcumin was shown to promote hippocampal neurogenesis and improve BDNF level in mouse model of chronic stress [102]. Also it acts by inhibiting the expression of MAO-A and MAO-B enzymes which results in increase the levels of norepinephrine, serotonin, and dopamine [103]. HgCl₂ perinatal exposure caused anxiety, depression and related hormones such as corticosterone and cortisol levels in the plasma of male mice offspring, it also shown that ability of curcumin to protect against mercury toxicity [104].

CONCLUSION

Today, the "golden spice" is still used as a culinary ingredient, but modern technology has made it possible to cultivate curcumin for a variety of food and health applications. The plant *Curcuma longa* has been used in food preparations since ancient times to give color and flavor. Turmeric has been shown to have antimicrobial, antimutagenic, and anticancer properties in various studies. The anti-inflammatory, anti-cancer, neurodegenerative, and anti-depressant effects of this spice have been proven. The results show that turmeric has medicinal value that can be used in both pharmacological and phytochemicals forms. While a lot of research has already been done on this plant, more research is needed to develop drugs. Greater awareness of its, benefits, traditional uses, side effects and more research on preparations with better bioavailability is needed. The collection of *Curcuma longa*, showing





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antidepressant effects, antioxidant properties from various journals, it can be concluded that plants are a very rich source of substances responsible for increasing the antidepressant, anxiolytic and antioxidant properties.

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CONFLICT OF INTEREST

Conflict of interest declared none.

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Table 1: Major volatile components in different part of *Curcuma longa*

Plant part used	Extraction method	Major chemical components	References
Rhizome	Steam distillation(SD)	8,9-Dehydro-9-formyl-cycloisolongifolene (35.3%), velleral (10.0%), germacrone (6.5%) and dihydrocostunolide (22.5%),	54
Leaf (HD)	Hydro distillation(HD)	Curzerene (16.2%), germacrone (13.6%), 1,8-cineole (13.5%), and camphor (5.7%)	55
Root	Hydro distillation(HD)	β -Elemenone (65.0%)	56
Fresh rhizome	Steam distillation(SD)	Curdione (50.6%) and germacrone (9.5%)	57
Dry root	Steam distillation(SD)	Germacrone (9.1%), curcumenol (8.5%), isocurcumenol (7.5%), and arzingiberone (5.1%)	58
Flower	Steam distillation(SD)	Curdione (27.0%) and an unidentified oxygenated sesquiterpene (12.3%)	59
Dry rhizome	Steam distillation(SD)	Curcumul (35.8%), 1,8-cineole (12.2%), ar-turmerone (7.0%), linalool (6.4%), humulene oxide (6.1%), and caryophyllene oxide (5.9%)	60

Table 2: Compounds responsible for the bioactive potential of *C. longa* essential oil

Plant Part	Compounds	Bioactivities	References
Rhizome	Ar-turmerone, curcumenol, β -turmerone, 8,9-dehydro-9-formylcycloisolongifolene, β -sesquiphellandrene, germacrone, arcurcumenol, α -himachalene, and andledane	Anti-age	72
Rhizome	Aromatic-turmerone, α -turmerone, and β -turmerone	Antioxidant	73
Rhizome	Ar-turmerone, β -turmerone, α -turmerone, ar-curcumenol, β -phellandrene, α -terpinene, limonene, γ -terpinene, and α -phellandrene	Antimicrobial	74
Leaves	α -Phellandrene, α -pinene, β -pinene, myrcene, α -cymene, limonene, and 1,8-cineole	Larvicide	75
Leaves	Cis-sesquibabinene hydrate, curzerenone, β -bisabolol, and farnesol	Antioxidant and antimicrobia	76
Rhizome	α -Turmerone, β -turmerone, α -phellandrene, terpinolene, α -zingiberene, β -sesquiphellandrene, ar-turmerol,	Antimicrotoxicogenic, Antioxidant and	77



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	curzerenone, and arturmerone	antifungal	
Rhizome	1,8-Cineole, α -phellandrene p-cymene, terpinolene α -zingiberene, and β sesquiphellandrene	Anticonvulsants, sedatives and anxiolytics	78

Table 3: Turmeric in different pharmacological activities

Turmeric Extracts	Pharmacological Activity	Model	Result	References
Turmeric root extract	Antioxidant Activity	Wistar rats	The formation of free radicals or ROS with DOX increases oxidative stress, which inhibiting the activity of endogenous antioxidants, thereby reducing the overall antioxidant status of the system. Taken together, the vitamins C and E in turmeric root extract treat all these symptoms individually.	79
Water extract of Turmeric Leaf (TLE)	Antioxidant Activity	Zebrafish models	We observed a decrease in the percentage of cells in their G1 phase when TL was administered at high concentrations. TLE treatment reduced ROS production and lipid peroxidation in H ₂ O ₂ -treated zebrafish models.	80
Nanoparticulate curcumin	Immuno modulatory Activity	Healthy albino mice	The anti-inflammatory effect of nanoparticle curcumin is strongest in the initial stages. Poly d,l-lactic-co-glycolic acid coated curcumin nanoparticles will enhance the bioavailability of curcumin for effective protection.	81
Regular turmeric extract	Anti-inflammatory Activity	inflammatory rat model	REVERC3 (Bisdemethoxy-Curcumin) has been shown to have anti-inflammatory properties by reducing carrageenan-induced paw edema. Compared with turmeric extract, REVERC3 is more effective in reducing inflammation.	82
Nanocurcumin	Immuno modulatory Activity	Immuno suppressed rat model	Nanocurcumin can be used as an immunomodulatory agent in mice receiving cyclophosphamide (CP), a drug that has been associated with anti-inflammatory effects.	83





Regulatory Requirements for Fixed-Dose Combination of Solid Dosage form in Europe

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ABSTRACT

This comprehensive study delves into the world of fixed-dose combinations (FDCs) in pharmaceuticals, shedding light on their merits, demerits, approval procedures, and pivotal role in public health. This finding highlights the importance of FDCs in simplifying medication regimens, enhancing patient compliance, and reducing costs. This study discusses the European Medicines Agency (EMA) in regulating FDCs within the European Union and the criteria for evaluating the rationality of FDCs, emphasizing the need for unique mechanisms of action and nontoxic formulations. It also discusses the challenges and advantages of FDCs in treating various diseases, particularly in lower- and middle-income countries. Furthermore, this study explored FDCs' development and regulatory requirements, emphasizing the need for pharmacodynamic and pharmacokinetic studies to ensure safety and effectiveness. It also addresses potential drug interactions and the critical role of risk-benefit assessments in the approval process. Overall, this study provides a comprehensive overview of FDCs, their development, regulatory considerations, and their impact on public health, offering valuable insights for healthcare professionals, regulators, and researchers in the field of pharmaceuticals process. In conclusion, this study offers a comprehensive overview of fixed-dose combinations, encompassing their development, regulatory considerations, and profound impact on public health. It serves as a valuable resource for healthcare professionals, regulators, and pharmaceutical researchers, providing a deeper understanding of this critical aspect of modern pharmaceuticals.



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Keywords: Fixed Dose Combinations, Pharmaceuticals, Medication Regimens, Patient Compliance, Healthcare, European Medicines Agency.

INTRODUCTION

The WHO has stated that a combination of two or more actives in a set ratio of dosages is acceptable. Regardless of the formulation or brand, When referring to a particular combination of active substances, this expression is used generally. It may be administered as a completed pharmaceutical product or as a single entity product supplied simultaneously. Fixed dose combinations (FDCs) are pharmaceutical products that combine two or more medications into a single dosage form. These products have a matching mode of action and improved therapeutic activity, opening up new therapy options for practically all human diseases. The creation of FDCs is becoming more and more crucial from the perspective of public health. (1) The European Medicines Agency (EMA) assists the work of the European Commission by contributing to the debate around medications inside the European Union (EU). A fixed-dose combination contains several active ingredients in a specified ratio and varying amounts. This type of medicine is widely used to treat a variety of conditions with a single prescription because of its easier administration and potential for greater therapeutic results. However, fixed-dose combinations may also have drawbacks, such as a higher possibility of side effects or medication interactions. FDCs are particularly well-liked and have had tremendous growth in the previous 10 years in the pharmaceutical sector. (2)

FDC's reasoning ought to be based on elements like

1. The drugs in the combination should each have a unique mechanism of action.
2. The pharmacokinetics shouldn't change significantly.
3. The components in the mixture shouldn't be poisonous in supra-additive amounts.(2)

The FDC was deemed to be reasonable if

1. Complementary modes of action for APIs
2. Lower the prevalence of AMA (antimicrobial agent) resistance
3. Boost the effectiveness of the combination
4. Reduce the frequency of harmful or unfavorable medication responses
5. Reduced pill load will increase medication therapy compliance.
6. Reduce the therapy's overall cost.
7. Each API should be given at a dosage that is suitable for defining or bigger populations.

The FDC was seen to be ludicrous if it shows.

1. There is no justification or explanation for the pairing.
2. There is no justification or explanation for the pairing. (3)

The combination has no rationale or explanation. FDC is essential for those with chronic illnesses. Their irrationality has raised some concerns and value in numerous nations, therefore their reasonable usage should be founded on strong medical principles. These concerns must be evaluated against the possible benefits of FDCs, notably their cost-effectiveness in specific situations. The use of fixed dosage combinations (FDCs) as opposed to individual prescriptions of the drugs has advantages. This must be weighed against issues like rising expenses and, in some circumstances, their irrationality. As a result, it is necessary to assess their value. The majority of infectious and non-infectious illnesses are prevalent in lower- and middle-income (LMIC) nations, where there are also cost-related problems. The content of the EU is given in Table I.(1,4)



**Balasubramanya et al.,****BACKGROUND**

Fixed-dose combinations come in various forms and are commonly found in household goods and medications, with multivitamins being one of the most common examples. Approximately 40 medication combinations are on the World Health Organization's list of essential medicines, however many of them are not currently accessible as fixed-dose combos. Due to a combination of diuretics and potassium chloride occasionally leading to ruptured stomach lining, fixed-dose combos suffered in the 1950s. Similarly, the creation of fixed-dose combos has gained popularity in India. but many have been approved without proper justification or evidence, leading to bans and withdrawals of licenses. In contrast, in countries with well-established regulatory frameworks such as the USA and the European Union, The number of fixed-dose combination drugs that have been approved has increased. The rise in these combinations may be due to an unmet medical need however, additional combination treatments can help close this gap. The advantages of fixed-dose combinations are covered in the section that follows.(5)

COMBINATION PACKS

The evaluation of combination packs will likewise follow the rules that govern fixed combination items. Contains multiple pharmaceuticals to be administered simultaneously or sequentially for a single therapeutic purpose.

MERITS OF FDC INCLUDE**Better treatment**

1. Instead of the present 7-8 tablets needed for the single medication regimen, just three or four FDC pills would be needed daily during the intense phase.
2. The current regimen has so many tablets that there is a higher chance that patients would forget to take a certain dosage, which might lead to insufficient treatment or, worse still, monotherapy, which increases the risk of developing drug resistance. Because FDCs contain all the drugs required for the regimen in a single pill, this risk might be decreased.
- 3.

Better case management

1. FDCs streamline the medication supply chain by minimizing the quantity of formulations that need to be ordered and shipped, especially to remote areas of the nation.
2. FDCs may be less expensive than other regimens due to reduced program expenditures for distribution and procurement.

Patient compliance

1. In comparison to monotherapy, FDC may improve patient compliance by requiring them to take fewer pills each day (e.g., 3-4 tablets per day as opposed to 15-16 tablets per day).
2. By easing patients' pill burden, medication compliance increased.

Synergistic effect

1. Sometimes a perfect mix of fixed dosage combinations comes together to provide a synergistic impact.
2. It has been demonstrated that the fixed-dose combination of these two drugs results in a synergistic analgesic effect, even though Tramadol has a prolonged analgesic impact and Paracetamol has a quick onset. (6)

POTENTIAL ADVANTAGES**Increasing activity**

1. Using the same dosage, combining substances can improve the therapeutic effect through synergistic or additive activity.
2. Synergistic activity occurs when one substance enhances the effect of another, resulting in a true therapeutic advantage. This can happen through pharmacodynamic and/or pharmacokinetic interactions.
3. Additive activity, on the other hand, is when the effects of one substance simply linearly add to those of another without interacting.



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4. Combining substances can also improve tolerance by lowering the dosage of drugs that have a small margin of safety. Additionally, combining a substance that counteracts the adverse effects of another can If the adverse impact is severe or frequent, increase tolerance.
5. Reducing the dose of a single drug might increase tolerance with a small margin of safety, or by including a chemical that mitigates the negative effects of another medication. This is only acceptable, though, if the negative effect is large or widespread.
6. The advantages of FDC for patient compliance are displayed in **Fig I.** (6)

DEMERITS OF FDC INCLUDE**Reduced dosage flexibility**

The limitation that fixed-dose antihypertensive combination medications have regarding the dosage flexibility for each of its constituent components is a drawback. Since Amlodipine and Atorvastatin.

Drug interactions

1. Depending on the chemical characteristics of the chemicals found in the environment, drug interactions between the active components and excipients used in FDCs may arise. (acidic/basic/humidity).
2. Drug interactions can affect treatment results, pose potential incompatibilities, and affect stability, which makes them serious issues.
3. The two medications become chemically unstable as a result. A redesigned tablet-in-tablet formulation has been created to stop this interaction. (1)

FDC APPROVAL PROCEDURE

A drug must complete two regulatory processes before it can be marketed in the European Union. Applications for marketing authorization and applications for clinical trials are these two processes. In contrast to marketing authorization requests, which are authorized at both the member state and centralised levels, clinical trial applications are approved at the member state level of the European Union (as of July 2013), which has 27 member states.

- NATIONALIZED PROCEDURE
- MUTUAL RECOGNITION PROCEDURE
- DECENTRALIZED PROCEDURE
- CENTRALIZED PROCEDURE

NATIONALIZED PROCEDURE

An applicant may only receive marketing authorization under the Nationalised procedure in one member state. The responsible authority of the Member State must receive an application before granting a national marketing license. New active compounds that are not needed by the Centralised procedure can get marketing authorization using this method. This process has a 210-day timeline. (7)

MUTUAL RECOGNITION PROCEDURE

In member states other than the Reference Member State (RMS), when the drug has already been authorized, applicants may get a marketing license by using the Mutual Recognition approach. Each EU member state where the applicant requests marketing authorization receives a copy of the same dossier with the essential information. The other Member States (the "CMS") to whom applications have previously been made are informed right away of the decision by the first Member State (the "RMS") to evaluate the medicinal product. RMS releases an analysis of its findings for additional states. The primary consumer of this kind of medicine approval process is the generic business. This procedure might take 390 days to complete. The MRP is displayed in **Fig II.** (8)



**Balasubramanya et al.,****DECENTRALIZED PROCEDURE**

Companies may employ this strategy to submit simultaneous requests for authorization for drugs that, in essence, do not meet the criteria for critical medicines under the centralized method and have not yet been approved in any EU country. Marketing authorization should be provided by the decision reached by the RMS & CMS in this decentralized way based on the assessment report created by the RMS and any comments made by the CMS. usually applies to products whose import into an EU country has not yet received authorization (Duration: 210 days). The Decentralized procedure is displayed in **Fig III. (9)**

CENTRALIZED PROCEDURE

A single marketing authorization and central authorization are the results of the centralized procedure, which leads to a European approval route and a single product. After being inspected throughout the EU, a product that through the centralized process has been authorized by the European Commission. The European Medicines Agency (EMA) coordinates the review process using the Member States' scientific competence. For certain things, the centralized approach is required, but not for others. The centralized procedure prohibits the usage of some items. The centralized procedure is displayed in **Fig IV. (10)**

DEVELOPMENT OF FIXED-DOSE COMBINATION

Harmonization of regulatory policies is encouraged among the countries that make up the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH). It has a significant impact on the creation of drug development standards by organizations like the EMA and FDA. The development of fixed-dose combinations follows a distinct set of standards than conventional drug research guidelines. Because there is presently no specific ICH guideline for combination drugs, the development of fixed-dose combinations is based on the ICH monotherapy recommendations. Major drug development agencies such as EMA, FDA, and WHO have their own set of guidelines for developing fixed-dose combinations. For instance, the EMA released while the FDA has two guideline documents about fixed-dose combinations and combination treatment, the "Guideline on clinical development of fixed combination medicinal products" was released in 2017. Guidelines for registration of fixed-dose combination medical products is another guideline for fixed-dose combinations that was prepared by the WHO.(5) The overall concept of all the recommendations for fixed-dose combinations is nicely summed up in the

EMA's three overall requirements

1. Justifications and grounds for the combination
2. Proving that all active ingredients contributed to the intended therapeutic result
3. The supporting evidence is pertinent to fixed combination medicine, which is critical if it is based on the administration of many active substances together. These bodies give careful thought to the separate components of the fixed-dose combination's approved status. Four examples from the WHO guideline give a summary that corresponds to the factors taken into account across all of the guidelines.

The four fixed-dose combination scenarios that can be authorized are listed below:

1. Generic fixed-dose combination of an existing fixed-dose combo
2. Fixed-dose combinations that are given in the same dosage as two different drugs now used in treatment
3. Combining two substances in a fixed dose that have never been mixed before or in a different dosing regimen
4. Combination of fixed-dose drugs comprising one or more novel chemical substances(11)

The primary pivotal trial or dose results clinical trial's choice of design was categorized as either:

1. Factorial design: Two or more combinations (different ratios)
2. Ray design: Two or more combinations (same ratio)
3. Single combination: One combination tested



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The number of patients and the number of arms in the clinical trial had a substantial impact on the body of data. When a factorial design was used in place of a ray design, there were noticeably more patients and arms. Naturally, there were far fewer dosages tried for a single combination than for a factorial design. (12)

Using tactics for development It was discovered that the fixed-dose combination's drug status had an impact on whether dose-finding trials were carried out throughout development. No dosage-finding research was conducted for 57% of the fixed-dose combos including two authorized medications. This strategy is outlined in the pertinent EMA guideline for the studied period (2009 guidelines), and the current investigation provides evidence that this strategy is practicable. Additionally, the EMA's most recent 2017 guidelines have a section outlining the evidence base that backs the same strategy. When fixed-dose combos were allowed without completing all stages of clinical research, an analysis of the FDA indicated a similar result. The fact that additional effective dosage levels or ratios may have been discovered by examining the drug-drug interaction space is a drawback of employing the existing dose levels. (13) To determine how to most effectively apply the requirement of demonstrating how various elements contribute to the overall impact, the design of a clinical trial was considered. In more than half (47%) of the permitted fixed-dose combinations, only one dosage was examined. A factorial design was employed by the vast majority (47+44%), which may be viewed as a subset of a single combination (which is in turn a subset of factorial design). The 2009 EMA recommendations distinguish between the Single combination and Factorial design groups by recommending the use of multilayer factorial designs.

Finally, only a small percentage of sponsors (8%) decided to use the ray design. To obtain a tailored therapy while using a fixed-dose combination, a patient must have access to a variety of allowed combination dosages. Extremely thorough factorial design studies are necessary to obtain approval for these combo doses. This means that adopting fixed-dose combinations for treatment personalization is made more difficult by the widespread adoption of the factorial design. Exposure-response modelling and model-based adaptive optimum design are possible alternatives to the factorial design research that may eliminate the requirement for human participants. Exposure-response analysis of fixed-dose combinations has been shown to have an enormous false-positive rate, rendering the method inapplicable. On the other hand, it has been demonstrated that longitudinal exposure-response analysis can offer a modelling strategy that can lessen the requirement for patients while still delivering accurate findings.

According to the study, modelling was not used in 22% of PK-PD modelling, 36% of PK modelling, or 42% of clinical development programs. By applying PK-PD modelling, Early results from clinical trials may be used to guide dose decisions and provide details on expected effect sizes. The PK profile may be applied to certain groups by taking into account factors like weight and age. The fact that just approximately half (58%) of the development programs used either PK or PKPD modelling as a development approach was therefore unexpected. The study's conclusion highlights the use of intriguing strategies such as using previous information, forgoing dose-finding studies, and medication reprofiling in the development of fixed-dose combinations. Although the significant usage of factorial design research is a barrier to this strategy, personalizing therapy with fixed-dose combinations may be a viable strategy to ensure sustained growth in the development of fixed-dose combinations. Last but not least, People who create fixed-dose combinations should give the use of modelling more serious thought given the benefits of PK-PD modelling and the lack of modelling in the creation of fixed-dose combinations as indicated in this study. (6,13)

INTERACTION OF DRUGS

When components are mixed to produce a fixed combination product, unexpected interactions between the components may take place. This might lead to unfavorable effects or a lack of effectiveness.

For example, One or more active compounds in a combination may make other active substances more hazardous or disguise their effects. The potential for interactions between active ingredients and excipients in vitro and in vivo must be taken into account, and investigated, and any Hazards need to be justified in a risk-benefit analysis and recorded. (14)



**Balasubramanya et al.,****INDICATIONS**

The intended use of a fixed combination product should be such that each active ingredient contributes to the overall therapeutic benefit of the product. The dosage and ratios of each active component in the product should be suitable for all of the indicated purposes. An indication is a known biological condition or state, such as a disease or affliction. The many components of a specified mix can be used to treat various symptoms of a single ailment. For a particular combination to be effective, these symptoms must typically occur concurrently and be of a significant intensity. Since certain symptoms may also be present in other conditions and the other substances in the combo may not be successful in treating them, they shouldn't be treated individually. When monotherapy has failed in a variety of situations, fixed combination medications may be recommended as second-line therapy or as first-line therapy for patients who have never taken either of the medications. The applicant should conduct the clinical development in the manner in which they have declared they intend to use the fixed combination. (15)

PHARMACODYNAMIC AND PHARMACOKINETIC STUDIES

When developing a set combination medicine, the potential for interactions between its constituent parts must be considered. The applicant must provide data to back up their claims that such interactions don't exist or that they are well-defined and understood. This is vital to ensure the medication's efficacy and safety.

Pharmacodynamic studies

The pharmacodynamic effects of the various medicines may be enhanced or amplified while taking a fixed combination of medications. To find the best dosage combination that yields a good response in this situation, it might be necessary to try several dose combinations. Using the concentration-response data, the ideal fixed combination may be chosen. This kind of information can assist in guaranteeing that the drug is efficient and offers a favorable benefit-risk balance.

Pharmacokinetic studies

When developing a fixed combination medicine, it is often crucial to show that the individual constituents do not interfere with one another's pharmacokinetic properties. However, in other situations (such as when administered with a metabolism inhibitor), the fixed combination may be meant to have a pharmacokinetic interaction. Individuals with that disease should also be looked into if a condition affects the pharmacokinetics of one of the medications, as should high-risk groups including the elderly and those with liver or renal impairment. This is necessary to guarantee the medication's efficacy and safety.

Safety and efficacy

Fixed dose combination drug applications submitted by Article 10b of Directive 2001/83/EC that have already been granted EEA authorization through a national or community process shall employ individual compounds. Complete safety and efficacy data must be provided for the fixed combination. In general, knowledge of the specific compounds is not required. Information about the separate compounds may, however, be provided in the application if the applicant can justify why there isn't specific information on the combination. It is acceptable to make a distinction between studies required for fixed combinations that are essentially innovative and those that are analogous to combinations that are now widely used and thoroughly studied. When the fixed combination matches a frequently used one, it is possible to provide an accurate bibliographical data analysis. If the data are thorough and reliable, using this analysis might reduce the number of clinical trials necessary. It will also make it simpler to pick the doses for each chemical and the proposed dose range for the fixed combination. The fixed combination is essentially new (e.g. involving active substances that are not usually combined or an unusual quantitative composition of usually combined substances), the data required are comparable to those for a novel chemical entity, and prior knowledge of the chemicals should be considered. (16)

Utilising a combination product as opposed to combining the use of individual substances

The use of a combination product, as opposed to individual substances, can offer several advantages in clinical situations. For example, a predetermined combination product ensures the proper ratio of active chemicals, guards





against potential product compatibility issues, and may make it easier to handle animals and maintain owner compliance.

RISK-BENEFIT ASSESSMENT

A risk-benefit analysis should be included in the dossier to balance potential advantages and downsides if the combination of active medications is appropriate. Combinations of substances with narrow therapeutic indices or critical dosage ranges may not be suitable for fixed combination products, as they require precise individual dosing. The use of redundant substances should be minimized, and each ingredient in a set combination must have a proven contribution to the combination. (17)

DOSSIER REQUIREMENTS FOR COMBINATION PRODUCTS

General requirements

New fixed combination products

If at least one unique active component is included in the combination veterinary medicinal product, a comprehensive dossier by Article 8 of Regulation (EU) 2019/6 must be submitted. Regulation (EU) 2019/6's Article 20 says that it is feasible to give the findings of safety and residue testing, as well as fresh pre-clinical research and clinical trials, provided all of the active components in the combination product have been used in prior veterinary medical products that are permitted, with the combination product only. Providing scientific references for each unique active component is optional, but if the applicant decides to do so, they should do so with the appropriate pharmacological and toxicological information, along with the required safety, residue, pre-clinical, and clinical data for the combination product, this will be regarded as a valid justification for concealing such information about the merged product. Pharmacological and toxicological studies using the final formulation may be necessary to further investigate the interactions between the active components and excipients in the fixed combination product, depending on the nature and intensity of the interactions. (18)

Combination products that meet the criteria for generic or hybrid application

If a combination product satisfies the requirements for a generic or hybrid product, Articles 18 or 19 of Regulation (EU) 2019/6 are applicable. According to the particular formulation (e.g., modifications in excipients) and delivery method, Information on the tolerance to and depletion of residues in the target animal species (e.g., local irritation) may be required. (19)

Specific Requirements

Part 1: Specific Requirements for safety and residues Documentation

The pharmacological details of the combination product must be provided to illustrate the mechanism of action and explore potential interactions. Any omissions must be justified. Toxicological data for the combination may also be necessary if the excipients and/or active ingredients interact, whether there is any potential for hidden toxicity, etc. When a synergistic effect occurs, further in-depth toxicological information will be required. The integrated product must demonstrate its safety for users, consumers, and the environment. It's critical to evaluate the combination's safety about the individual product safety of the active components. Research on user safety that focuses in particular on the consequences on the person delivering the product or any other people who may be exposed during or after treatment (for example, children handling animals after treatment) should always be conducted on the final formulation. To undertake user safety tests as needed, the fixed combination product would be used, and the results would be provided in the dossier. The CVMP guideline on user safety for pharmaceutical veterinary medicinal goods (EMA/CVMP/543/03) describes user safety research and evaluations. It is necessary to undertake an Environmental Risk Assessment (ERA) to determine how the combined product may affect the environment. Data by VICH GL6 and GL38 (ERA stages I and II, respectively) may be submitted for the aforementioned drugs, only if scientifically warranted. To protect consumers, withdrawal times must be defined for animals used for food production. To establish withdrawal times, residue depletion tests for foodstuffs (based on species) must be carried out using the fixed combination/final formulation. It is necessary to prove the presence of the pharmacologically active ingredients and any important metabolites in the predetermined combination product in the animal's body or



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milk, eggs, or honey by the proper examinations. For injectable products (intramuscular or subcutaneous) designed for livestock, data on residual depletion at injection sites must be given.

Part 2: Specific requirements for pre-clinical and clinical Documentation

A fixed combination product's effectiveness and target animal safety should both be examined in the animal species for which it is designed. (20)

Pre-clinical data

To demonstrate the combination product's mode of action (e.g., additive or synergistic), explore potential connections, or categorically demonstrate that no interactions occur, pre-clinical evidence (pharmacokinetic and/or pharmacodynamic) must be provided. If the fixed combination is founded on pharmacokinetic interactions, these interactions ought to be studied in healthy animals of the target species.

Dose determination and dose confirmation studies

It's important to back up the recommended dosing regimen. If pharmacological research has conclusively shown that there are no interactions between the active ingredients, the basis for dose selection may be based on information for each unique active ingredient. If the potential benefit of the combination product depends on synergistic or additive activity, it may be required to test a variety of dose combinations for each component to determine the appropriate quantitative relationship between them in the fixed combination product. For dosage confirmation studies, the final formulation must always be utilized.

Tolerance

If an increased tolerance is the justification for the fixed combination, target animal safety testing should also include an untreated control group or a reference therapy.

Clinical data

When performing clinical trials, always utilize the final formulation of the combination product. It's critical to contrast the target animal safety and efficacy of the combination product with those of the individual active components.

Resistance

An evaluation of the possibility for the emergence of resistance will be required for antibacterial or antiparasitic fixed combinations.

Exceptions

If one of the active components of a combination drug doesn't necessarily have a therapeutic effect but instead only intensifies or completes the effect of the other component (for example, beta-lactams and beta-lactamase inhibitors), the efficacy of the combination product should be compared to the principal active ingredient's effectiveness when taken by itself. It should be shown that the active ingredient has the desired impact even in the absence of direct therapeutic activity (e.g. the fixed combination must be superior to the main component when given alone). The advantages of each active component in combinations of vitamins, minerals, and oligo-elements that are fixed may be difficult to ascertain. Such combinations are recognized as useful and safe in these circumstances provided the specified indications are limited to deficiency diseases when therapy with a specific combination is acceptable and the maximum doses do not exceed internationally and scientifically recognized restrictions. Combinations of vitamins and antibiotics are not covered by this exclusion. Additionally, a particular combination of nutrients and electrolytes may not meet the requirements of this advice. Any experimental data that contrasts the various effects of each medication in these conditions is meaningless. (20)



**Balasubramanya et al.,****SUMMARY AND CONCLUSION**

In conclusion, (FDCs) are a vital component of modern pharmaceuticals, offering a multitude of advantages that include simplified treatment regimens, enhanced patient compliance, and the potential for cost reduction. They have emerged as powerful tools in addressing a wide spectrum of diseases, especially in regions with limited healthcare resources. The (EMA) oversight and stringent evaluation criteria ensure that FDCs meet the highest standards of safety, efficacy, and rationality. The demand for FDCs has grown significantly, particularly in lower- and middle-income countries, where cost-effective and simplified therapies are crucial. However, the development and approval of FDCs require meticulous attention to pharmacodynamic and pharmacokinetic interactions to guarantee their safety and effectiveness. Risk-benefit assessments play a pivotal role in the approval process, ensuring that the benefits of FDCs outweigh any potential drawbacks. As the pharmaceutical industry continues to evolve, the development of FDCs holds the promise of addressing unmet medical needs, improving treatment outcomes, and enhancing the overall quality of healthcare. Researchers, regulators, and healthcare professionals must continue collaborating and innovating in this field, ultimately advancing public health by harnessing the full potential of Dose Combinations. In a world where healthcare accessibility and efficiency are paramount, FDCs represent a critical step forward in providing safe, effective, and accessible treatments to diverse patient populations.

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Table 1 : The contents of FDC in Europe

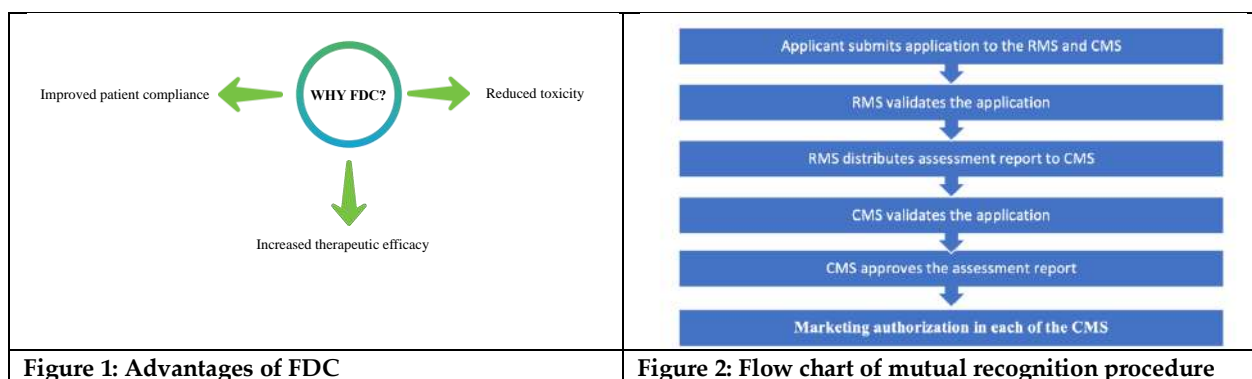
CONTENTS	EUROPE UNION 
Authority	European medicine agency(EMA)
Committees	Committee for Human Medicinal Products
various registration methods	1. Centralised procedure 2. Decentralised procedure 3. Mutual recognition procedure 4. National procedure
Types of application	1. Full dossier application

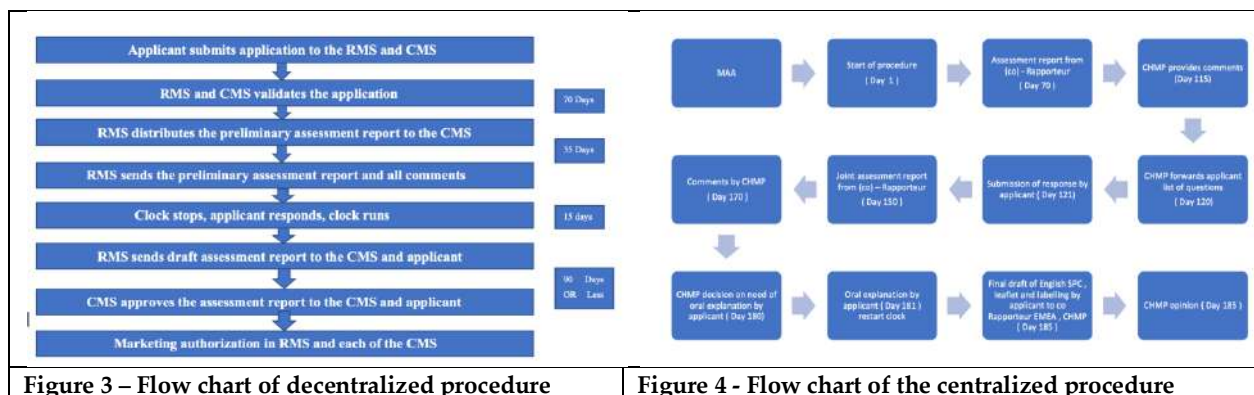




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	2. Generic product application 3. Hybrid application 4. Biosimilar application 5. Bibliographic application 6. Fixed-dose application 7. Informed consent application
CTD presentation	eCTD
eCTD year implemented	2005
Application for marketing authorization and fee schedule	National fee(including hybrid applications): £103,059 Decentralised procedure
Approval time	~12months
No of copies	1
BCS	If all APIs fall into BCS Classes I or III, FDC products can be allowed.
TSE?BSE study data	Required
Braille code	It is necessary for labeling
Post approval changes	Type IA, IB, and II variations



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Population Status and Distribution Pattern of Indian Peafowl (*Pavo cristatus* L.) in Specific Sites in Bharatpur Rajasthan

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ABSTRACT

The observations showed quite a fluctuation in the population and distribution of peafowl, *Pavo cristatus* in different areas of Bharatpur District. These are Village Kandholi in Tehsil Rupbas, Village Saman-Penghore in Tehsil Kumher, and Anirudh Nagar colony From September 2020 to August 2023. All the experimental sites showed the maximum population of peafowl in August due to the availability of suitable mating sites and reproduction, coinciding with the spring season. The fluctuation in the population and distribution was marked due to the behavior of *P. cristatus* i.e., variance in the availability of food, roosting, and site of reproduction. Anirudh Nagar Colony is an urban area that provides a man-made environment to the Indian Peafowl; therefore, the population of *P. cristatus* remained relatively small compared to other sites.

Keywords: Distribution, *Pavo cristatus*, population, roosting.

INTRODUCTION

The Indian peafowl, *Pavo cristatus* Linnaeus 1758 is a resident breeder of South Asia. The distribution of peafowl in India is patchy but ranges from the Himalayas in the north to peninsular India in the south. They belong to the family Phasianidae of order Galliformes, which is a group of more than 250 bird species including peafowls, jungle fowls, pheasants, partridges, turkeys, grouse, chickens, quails, etc (Johnsgard, 1986). The genus, *Pavo*, is derived from the Latin word *pawe*, meaning peacock, and the species name *cristatus*, refers to the crest (Sclater, 1860). Birds



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are the most essential part of our ecosystems and Indian Peafowl acts as a bio indicator of the changing climate (Nameer 2020). They are highly sensitive to changes in their environment *i.e.*, habitat destruction, and environmental pollution due to the activity of humans. Problems of bird survival are thus early warnings or signals of problems for man for their own survival in nature. However, the Red Data Book of the International Union for Conservation of Nature (IUCN) listed that about one-third of species of pheasants are endangered. Therefore, peafowl are the most sensitive birds that live near the human population and may be used as a sign of environmental values (Ambuel and Temple, 1983). Henceforth, to assess the suitability of the environment, the present study has been designed on the population and distribution of Indian peafowl at these sites. The abundance of bird species is largely influenced by the spatiotemporal distribution of some key environmental resources (Girma *et al.* 2017).

MATERIALS AND METHODS

Study area

The present study was carried out from September 2020 to August 2023 in different areas of Bharatpur District. These are Village Kandholi in Tehsil Rupbas, Village Saman-Penghore in Tehsil Kumher and Anirudh Nagar colony. The locations have a large stretch of hilly area with rich biodiversity and agricultural fields, a large area of agricultural fields with dense vegetation, and Urban area with a dense human population respectively.

Research Methodology

In the present study, the population of Indian peafowl, *Pavo cristatus* was recorded at three experimental sites *i.e.* Saman village, Kandholi and Anirudh Nagar. The observations were recorded in the morning at every experimental site. The survey was carried out immediately after sunrise, normally from 06.00 to 09.00 am with a normal speed of walk. The survey was carried out throughout the year on a weekly basis. The point transect method was used for the survey as suggested by Verner, (1985). The movements of the birds were noted as precisely as possible so as to avoid pseudo-replication. Observations were taken with the help of binoculars, photography, and video graphy done by Nikon d3500 DSLR Camera. During observations different developmental stages (sub-adult, male, male with train, and female) of Indian peafowl were also counted for population estimation (Johnsingh and Murali, 1978 and Soliappan *et al.*, 2002). The observations on the population of peafowl were recorded at five places at every experimental site. The statistical calculations were presented as mean values of the population with standard error of the mean (SE) in the tables.

RESULTS

Population

The population of Indian peafowl was recorded for three successive years (2020-21, 2021-22, and 2022-23) at three different places which are Village Penghore-Saman, Village Kandholi, and Anirudh Nagar Colony in Bharatpur district. At Village Penghore-Saman population of sub-adult, male, male with train (TM) and female was recorded highest (14.00 ± 0.71 , 14.00 ± 0.71 , 18.00 ± 0.71 and 24.00 ± 0.71 individuals, respectively) in the month of September 2020 during the experiment (Table 1). In contrast, the population of *P. cristatus* was recorded minimum as 1.00 ± 0.32 sub-adult, 1.00 ± 0.32 male, 4.00 ± 0.32 male with train, and 8.00 ± 0.45 female in the month of June 2023, respectively (Table 3). At Village Kandholi, the maximum population of sub-adult, male, male with train, and female was obtained as 10.00 ± 0.63 sub-adult, 8.00 ± 0.35 male, 15.00 ± 0.71 male with train and 22.00 ± 0.71 female, respectively in the month of September 2020 (Table 4). On the other hand, the minimum population of *P. cristatus* was recorded as 1.00 ± 0.32 sub-adult, 1.00 ± 0.32 male, 3.00 ± 0.32 male with train, and 7.00 ± 0.35 female in the month of January 2023, respectively (Table 6). As far as Anirudh Nagar Colony was concerned, the maximum population of sub-adult, male, male with train, and female was obtained as 8.00 ± 0.35 sub-adult, 7.00 ± 0.32 male, 14.00 ± 0.71 male with train, and 20.00 ± 0.71 female, respectively in the month of September 2020 (Table 7). On the other hand, the minimum population of



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P. cristatus was recorded as 0.00 ± 0.00 sub-adult, 1.00 ± 0.32 male, 0.00 ± 0.00 male with train, and 5.00 ± 0.45 female in the month of January 2023, respectively (Table 9).

Distribution

As far as distribution was concerned, among different locations, Indian peafowl, *Pavo cristatus* attained maximum values as 24.00 ± 0.71 female followed by 18.00 ± 0.71 male with train, 14.00 ± 0.71 male, 14.00 ± 0.71 sub-adult at Village Penghore-Saman. However, at other sites (Village Kandholi, and Anirudh Nagar Colony) remained statistically low.

DISCUSSION

The COVID-19 pandemic, caused by the novel corona virus SARS-CoV-2, prompted governments worldwide to impose lockdowns and travel restrictions in early 2020 to curb the spread of the virus. These lockdowns led to profound changes in human behavior and reduced human disturbances, such as industrial activity, transportation, and tourism, during the lockdown period resulting in a notable increase in Peafowl numbers. Therefore the number of Peafowl at every site was high during the lockdown period (2020-21) and remained statistically low in 2021-22 and 2022-23. Similar observations were recorded by Madhok and Gulati (2022) who studied that Avian species reclaimed urban habitat during India's COVID-19 lockdown there was a 16% increase in the number of bird species during the lockdown in the 20 most populous cities in India. The findings on population status and distribution pattern of Indian peafowl *P. cristatus* L. in district Bharatpur revealed that peafowl are distributed in both natural and man-made environments (crop fields and colonies). In a man-made environment (Anirudh Nagar Colony), the highest number of peafowl was recorded in the month of September. In September, most of the peafowl come out to search for suitable sites for their mating and reproduction. This hypothesis was considered by Yasmin (1995), Yasmin and Yahya (1996), Mateos (1998), Deeming and Wadland (2002), and Harikrishnan et al. (2010). In contrast, a minimum population was observed in the month of June possibly due to increased temperature. This population and distribution variation is attributed to their habitat and living style. Similar observations were recorded by Ramesh (2003) at Great Himalaya National Park, in Western Himalaya, and also by Das and Sivakumar (2009) at Chilla Raiyge, Rajaji National Park, in North India. The predation pressure and local people disturbances could cause the peafowl to concentrate in a particular area for foraging. Generally, the peafowls were observed and recorded from the agricultural fields and also from the areas inhabited by tall shrubby trees. It is because by the fact that the shrubby trees provide shade and the agricultural fields are the source of their feed.

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Table 1. Population of Indian Peafowl *Pavo cristatus* at village Penghore- Saman (Kumher) during year 2020-21

Month	Standard Week	Sub Adult	Male	Male with Train	Female	Total
September	36	14.00±0.71	14.00±0.71	18.00±0.71	24.00±0.71	70.00±0.84
	37	14.00±0.71	14.00±0.89	18.00±0.71	24.00±0.71	70.00±1.22
	38	13.00±0.71	13.00±0.71	17.00±0.71	22.00±0.71	65.00±2.83
	39	13.00±0.71	13.00±0.71	16.00±0.71	22.00±0.71	64.00±2.83
October	40	12.00±0.71	12.00±0.71	16.00±0.71	22.00±0.71	62.00±2.76
	41	12.00±0.71	12.00±0.71	15.00±0.71	20.00±0.71	59.00±2.76
	42	12.00±0.71	10.00±0.63	15.00±0.71	20.00±0.71	57.00±2.39
	43	11.00±0.71	10.00±0.63	14.00±0.71	20.00±0.71	55.00±1.90
November	44	11.00±0.71	10.00±0.63	14.00±0.71	18.00±0.71	53.00±1.90
	45	10.00±0.63	10.00±0.63	12.00±0.71	18.00±0.71	50.00±2.17
	46	10.00±0.63	9.00±0.61	12.00±0.71	17.00±0.71	48.00±2.13
	47	9.00±0.61	9.00±0.55	12.00±0.71	17.00±0.71	47.00±2.24
	48	10.00±0.63	9.00±0.61	12.00±0.71	16.00±0.71	47.00±2.13
December	49	9.00±0.61	8.00±0.35	10.00±0.63	15.00±0.71	42.00±1.47
	50	9.00±0.61	8.00±0.35	10.00±0.63	15.00±0.71	42.00±1.47
	51	8.00±0.35	7.00±0.45	8.00±0.35	14.00±0.71	37.00±0.84
	52	8.00±0.35	7.00±0.45	8.00±0.35	14.00±0.71	37.00±0.84
January	1	8.00±0.35	6.00±0.32	6.00±0.45	12.00±0.71	32.00±0.80
	2	6.00±0.32	6.00±0.32	6.00±0.45	8.00±0.35	26.00±1.28
	3	6.00±0.45	5.00±0.32	4.00±0.32	6.00±0.45	21.00±1.10
	4	5.00±0.32	4.00±0.32	2.00±0.32	4.00±0.32	15.00±0.32
	5	5.00±0.32	4.00±0.32	3.00±0.32	6.00±0.45	18.00±0.55
February	6	7.00±0.35	5.00±0.32	6.00±0.45	8.00±0.35	26.00±1.14
	7	7.00±0.35	6.00±0.45	7.00±0.35	10.00±0.63	30.00±1.38





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	8	8.00±0.35	6.00±0.45	8.00±0.35	12.00±0.71	34.00±0.84
	9	9.00±0.61	7.00±0.35	9.00±0.61	14.00±0.71	39.00±1.53
March	10	9.00±0.61	8.00±0.35	9.00±0.61	16.00±0.71	42.00±1.53
	11	11.00±0.71	8.00±0.35	10.00±0.63	16.00±0.71	45.00±1.32
	12	12.00±0.71	10.00±0.63	10.00±0.45	17.00±0.71	49.00±2.12
	13	12.00±0.71	10.00±0.63	10.00±0.45	15.00±0.71	47.00±2.12
April	14	10.00±0.63	10.00±0.63	10.00±0.45	16.00±0.71	46.00±2.02
	15	12.00±0.71	10.00±0.63	12.00±0.71	16.00±0.71	50.00±2.35
	16	14.00±0.71	9.00±0.61	12.00±0.71	18.00±0.71	53.00±2.48
	17	12.00±0.71	9.00±0.61	13.00±0.71	20.00±0.71	54.00±2.48
May	18	11.00±0.71	9.00±0.61	11.00±0.71	20.00±0.71	51.00±2.08
	19	11.00±0.71	9.00±0.61	10.00±0.63	18.00±0.71	48.00±1.80
	20	10.00±0.63	8.00±0.35	10.00±0.45	16.00±0.71	44.00±1.50
	21	10.00±0.63	8.00±0.35	9.00±0.61	14.00±0.71	41.00±1.47
	22	9.00±0.61	6.00±0.32	9.00±0.61	12.00±0.71	36.00±1.92
June	23	8.00±0.35	5.00±0.32	8.00±0.35	10.00±0.63	31.00±0.89
	24	6.00±0.45	2.00±0.32	8.00±0.35	10.00±0.63	26.00±1.07
	25	5.00±0.45	2.00±0.32	5.00±0.32	7.00±0.45	19.00±1.30
	26	3.00±0.32	2.00±0.32	4.00±0.32	9.00±0.61	18.00±1.28
July	27	4.00±0.32	4.00±0.32	4.00±0.45	10.00±0.63	22.00±1.30
	28	8.00±0.35	6.00±0.45	8.00±0.35	14.00±0.71	36.00±0.84
	29	10.00±0.63	8.00±0.35	10.00±0.63	16.00±0.71	44.00±1.80
	30	10.00±0.63	8.00±0.35	12.00±0.71	18.00±0.71	48.00±1.66
August	31	11.00±0.71	10.00±0.63	12.00±0.71	18.00±0.71	51.00±1.92
	32	12.00±0.71	10.00±0.63	14.00±0.71	20.00±0.71	56.00±2.35
	33	12.00±0.71	10.00±0.63	14.00±0.71	20.00±0.71	56.00±2.39
	34	13.00±0.71	11.00±0.71	15.00±0.71	22.00±0.71	61.00±2.02
	35	14.00±0.71	12.00±0.71	16.00±0.71	24.00±0.71	66.00±2.77

Table 2. Population of Indian Peafowl *Pavo cristatus* at village Penghore- Saman (Kumher) during year 2021-22

Month	Standard Week	Sub Adult	Male	Male with Train	Female	Total
September	36	12.00±0.71	11.00±0.71	16.00±0.71	22.00±0.71	61.00±2.07
	37	12.00±0.71	11.00±0.71	16.00±0.71	22.00±0.71	61.00±2.07
	38	10.00±0.45	10.00±0.71	15.00±0.71	21.00±0.71	56.00±1.22
	39	11.00±0.71	10.00±0.45	15.00±0.55	20.00±0.71	56.00±1.34
October	40	10.00±0.45	11.00±0.71	14.00±0.71	20.00±0.71	55.00±1.58
	41	10.00±0.45	10.00±0.55	14.00±0.71	2.00±0.71	54.00±1.10
	42	10.00±0.45	9.00±0.61	13.00±0.71	18.00±0.71	50.00±1.53
	43	9.00±0.61	8.00±0.35	12.00±0.71	18.00±0.71	47.00±1.50
	44	9.00±0.61	8.00±0.35	12.00±0.71	17.00±0.71	46.00±1.50
November	45	8.00±0.35	7.00±0.35	11.00±0.71	17.00±0.71	43.00±0.89
	46	8.00±0.35	7.00±0.35	10.00±0.45	16.00±0.71	41.00±0.89
	47	9.00±0.61	6.00±0.42	10.00±0.45	16.00±0.71	41.00±0.97
	48	8.00±0.35	6.00±0.42	10.00±0.45	15.00±0.71	39.00±0.60
December	49	8.00±0.35	5.00±0.32	9.00±0.61	14.00±0.71	36.00±0.81
	50	7.00±0.35	5.00±0.32	9.00±0.61	14.00±0.71	35.00±0.81





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	51	7.00±0.35	5.00±0.32	8.00±0.35	12.00±0.71	32.00±0.32
	52	7.00±0.35	6.00±0.42	8.00±0.35	12.00±0.71	33.00±0.49
January	1	6.00±0.42	5.00±0.32	7.00±0.35	10.00±0.45	28.00±0.68
	2	5.00±0.32	4.00±0.32	5.00±0.32	8.00±0.35	22.00±0.73
	3	5.00±0.32	3.00±0.32	4.00±0.32	8.00±0.35	20.00±0.49
	4	4.00±0.32	2.00±0.32	2.00±0.32	7.00±0.32	15.00±0.86
	5	4.00±0.32	2.00±0.32	3.00±0.32	8.00±0.35	17.00±0.80
February	6	6.00±0.42	3.00±0.32	5.00±0.32	10.00±0.45	24.00±0.80
	7	6.00±0.42	4.00±0.32	6.00±0.42	12.00±0.71	28.00±1.64
	8	8.00±0.35	5.00±0.32	7.00±0.35	12.00±0.71	32.00±0.32
	9	8.00±0.35	5.00±0.32	8.00±0.45	14.00±0.71	35.00±0.73
March	10	8.00±0.35	5.00±0.32	9.00±0.61	15.00±0.71	37.00±0.81
	11	10.00±0.45	6.00±0.42	9.00±0.61	14.00±0.71	39.00±0.97
	12	10.00±0.45	7.00±0.35	10.00±0.55	15.00±0.71	42.00±1.11
	13	11.00±0.71	7.00±0.35	10.00±0.55	15.00±0.71	43.00±1.16
April	14	10.00±0.45	8.00±0.35	9.00±0.61	16.00±0.71	43.00±0.87
	15	12.00±0.71	8.00±0.35	9.00±0.61	16.00±0.71	45.00±1.50
	16	12.00±0.71	9.00±0.61	12.00±0.71	18.00±0.71	51.00±2.37
	17	13.00±0.71	9.00±0.61	11.00±0.71	18.00±0.71	51.00±2.06
May	18	12.00±0.55	8.00±0.35	12.00±0.71	16.00±0.71	48.00±1.50
	19	10.00±0.45	10.00±0.55	11.00±0.71	15.00±0.71	46.00±1.22
	20	10.00±0.55	9.00±0.61	10.00±0.45	14.00±0.71	43.00±1.11
	21	8.00±0.35	9.00±0.61	10.00±1.45	14.00±0.71	41.00±0.87
	22	8.00±0.35	8.00±0.45	9.00±0.61	12.00±0.71	37.00±0.87
June	23	6.00±0.42	5.00±0.32	9.00±0.61	10.00±0.45	30.00±0.49
	24	4.00±0.32	3.00±0.32	8.00±0.35	12.00±0.71	27.00±0.66
	25	2.00±0.32	3.00±0.32	8.00±0.35	10.00±0.63	23.00±0.73
	26	1.00±0.32	2.00±0.32	7.00±0.35	10.00±0.45	20.00±0.97
July	27	3.00±0.32	4.00±0.32	7.00±0.35	14.00±0.71	28.00±0.66
	28	6.00±0.42	5.00±0.32	9.00±0.61	15.00±0.71	35.00±1.20
	29	8.00±0.63	6.00±0.42	10.00±0.45	16.00±0.71	40.00±1.07
	30	8.00±0.35	7.00±0.35	11.00±0.71	16.00±0.71	42.00±0.89
	31	7.00±0.35	8.00±0.35	12.00±0.71	18.00±0.71	45.00±1.05
August	32	8.00±0.35	8.00±0.45	12.00±0.71	18.00±0.71	46.00±1.16
	33	8.00±0.35	9.00±0.61	12.00±0.71	20.00±0.71	49.00±1.63
	34	10.00±0.45	9.00±0.61	14.00±0.71	20.00±0.71	53.00±1.98
	35	10.00±0.45	9.00±0.61	14.00±0.71	22.00±0.71	55.00±1.53

Table 3. Population of Indian Peafowl *Pavo cristatus* at village Penghore- Saman (Kumher) during year 2022-23

Month	Standard Week	Sub Adult	Male	Male with Train	Female	Total
September	36	8.00±0.35	8.00±0.45	12.00±0.71	20.00±0.71	48.00±0.97
	37	8.00±0.35	9.00±0.61	12.00±0.71	20.00±0.71	49.00±1.53
	38	9.00±0.61	8.00±0.35	12.00±0.71	18.00±0.71	47.00±1.53
	39	8.00±0.35	8.00±0.45	10.00±0.45	19.00±0.71	45.00±1.16
October	40	8.00±0.35	7.00±0.35	10.00±0.55	18.00±0.71	43.00±0.71
	41	7.00±0.35	7.00±0.35	10.00±0.71	18.00±0.71	42.00±0.71





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	42	7.00±0.35	7.00±0.35	11.00±0.71	19.00±0.71	44.00±1.05
	43	7.00±0.35	6.00±0.32	10.00±0.37	18.00±0.71	41.00±1.14
	44	6.00±0.32	6.00±0.32	10.00±0.55	16.00±0.71	38.00±1.64
November	45	6.00±0.32	6.00±0.32	9.00±0.61	16.00±0.71	37.00±1.56
	46	6.00±0.32	5.00±0.32	9.00±0.61	14.00±0.71	34.00±1.39
	47	5.00±0.32	5.00±0.32	8.00±0.35	14.00±0.71	32.00±0.80
	48	6.00±0.32	5.00±0.32	9.00±0.61	15.00±0.71	35.00±1.02
December	49	5.00±0.32	5.00±0.32	8.00±0.35	16.00±0.71	34.00±0.80
	50	4.00±0.32	4.00±0.32	8.00±0.35	14.00±0.55	30.00±0.37
	51	3.00±0.32	4.00±0.32	8.00±0.35	14.00±0.55	29.00±0.37
	52	2.00±0.32	4.00±0.32	7.00±0.35	12.00±0.55	25.00±0.49
January	1	2.00±0.32	4.00±0.32	7.00±0.35	10.00±0.32	23.00±0.45
	2	3.00±0.32	3.00±0.32	6.00±0.32	10.00±0.45	22.00±0.84
	3	2.00±0.32	1.00±0.32	5.00±0.32	9.00±0.61	17.00±1.11
	4	1.00±0.32	1.00±0.32	4.00±0.32	8.00±0.45	14.00±0.84
	5	2.00±0.32	2.00±0.32	3.00±0.32	8.00±0.45	15.00±0.55
February	6	5.00±0.32	3.00±0.32	5.00±0.32	9.00±0.61	22.00±1.11
	7	5.00±0.32	4.00±0.32	6.00±0.32	10.00±0.45	25.00±0.32
	8	4.00±0.32	4.00±0.32	6.00±0.32	10.00±0.45	24.00±0.55
	9	4.00±0.32	5.00±0.32	7.00±0.35	11.00±0.71	27.00±0.58
March	10	4.00±0.32	4.00±0.32	7.00±0.35	11.00±0.71	26.00±0.58
	11	5.00±0.32	4.00±0.32	7.00±0.35	12.00±0.55	28.00±0.58
	12	4.00±0.32	5.00±0.32	8.00±0.35	12.00±0.55	29.00±0.58
	13	4.00±0.32	5.00±0.32	8.00±0.35	13.00±0.71	30.00±0.86
April	14	4.00±0.32	5.00±0.32	9.00±0.45	14.00±0.55	32.00±0.84
	15	4.00±0.32	6.00±0.32	8.00±0.35	14.00±0.55	32.00±0.20
	16	4.00±0.32	5.00±0.32	9.00±0.61	15.00±0.71	33.00±1.369
	17	3.00±0.32	6.00±0.32	9.00±0.61	16.00±0.71	34.00±1.36
	18	4.00±0.32	4.00±0.32	8.00±0.35	16.00±0.71	32.00±1.11
May	19	4.00±0.32	4.00±0.32	8.00±0.35	14.00±0.71	30.00±1.11
	20	3.00±0.32	4.00±0.32	7.00±0.35	13.00±0.71	27.00±0.73
	21	3.00±0.32	4.00±0.32	8.00±0.35	13.00±0.71	28.00±0.66
	22	2.00±0.32	3.00±0.32	7.00±0.35	12.00±0.55	24.00±0.66
June	23	2.00±0.32	2.00±0.32	7.00±0.35	10.00±0.45	21.00±0.80
	24	2.00±0.32	2.00±0.32	6.00±0.32	10.00±0.45	20.00±0.77
	25	1.00±0.32	1.00±0.32	5.00±0.32	9.00±0.61	16.00±0.49
	26	1.00±0.32	1.00±0.32	4.00±0.32	8.00±0.45	14.00±0.55
July	27	3.00±0.32	2.00±0.32	3.00±0.32	9.00±0.61	17.00±0.80
	28	4.00±0.32	3.00±0.32	3.00±0.32	10.00±0.45	20.00±0.45
	29	5.00±0.32	4.00±0.32	5.00±0.32	12.00±0.55	26.00±0.55
	30	5.00±0.32	5.00±0.32	6.00±0.32	13.00±0.71	29.00±0.89
	31	6.00±0.32	6.00±0.32	6.00±0.42	15.00±0.71	33.00±1.46
August	32	7.00±0.35	6.00±0.42	7.00±0.45	15.00±0.71	35.00±0.87
	33	7.00±0.35	7.00±0.35	7.00±0.45	16.00±0.71	37.00±0.89
	34	8.00±0.35	7.00±0.35	8.00±0.45	16.00±0.71	39.00±0.89
	35	8.00±0.35	8.00±0.45	8.00±0.45	16.00±0.71	40.00±1.02





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Table 4. The population of Indian Peafowl *Pavo cristatus* at village Kandholi (Roopvas) during year 2020-21

Month	Standard Week	Sub Adult	Male	Male with Train	Female	Total
September	36	10.00±0.63	8.00±0.35	15.00±0.71	22.00±0.71	55.00±1.16
	37	10.00±0.63	9.00±0.35	14.00±0.63	22.00±0.71	55.00±0.80
	38	9.00±0.35	8.00±0.35	14.00±0.71	20.00±0.71	51.00±0.97
	39	9.00±0.35	8.00±0.35	12.00±0.71	20.00±0.71	49.00±1.16
October	40	8.00±0.35	7.00±0.35	12.00±0.45	19.00±0.71	46.00±0.86
	41	8.00±0.35	7.00±0.35	10.00±0.63	19.00±0.71	44.00±0.58
	42	8.00±0.35	6.00±0.35	10.00±0.63	18.00±0.71	42.00±0.92
	43	7.00±0.35	7.00±0.35	9.00±0.35	18.00±0.71	41.00±0.97
November	44	7.00±0.35	6.00±0.35	9.00±0.35	17.00±0.45	39.00±1.02
	45	7.00±0.35	6.00±0.35	8.00±0.35	17.00±0.71	38.00±1.02
	46	7.00±0.35	6.00±0.35	8.00±0.35	16.00±0.71	37.00±0.84
	47	6.00±0.35	5.00±0.45	8.00±0.35	16.00±0.71	35.00±0.97
	48	6.00±0.35	6.00±0.35	7.00±0.35	16.00±0.71	35.00±0.86
December	49	6.00±0.35	5.00±0.32	7.00±0.35	15.00±0.71	33.00±0.80
	50	5.00±0.32	5.00±0.32	7.00±0.35	15.00±0.71	32.00±1.16
	51	5.00±0.32	5.00±0.32	6.00±0.35	15.00±0.71	31.00±0.66
	52	5.00±0.32	5.00±0.32	6.00±0.35	14.00±0.71	30.00±0.66
January	1	4.00±0.32	4.00±0.32	6.00±0.35	12.00±0.71	26.00±0.66
	2	4.00±0.32	4.00±0.32	5.00±0.45	10.00±0.63	23.00±0.89
	3	3.00±0.32	2.00±0.32	5.00±0.45	9.00±0.35	19.00±0.86
	4	3.00±0.32	2.00±0.32	3.00±0.32	8.00±0.35	16.00±1.16
	5	4.00±0.32	3.00±0.32	4.00±0.32	8.00±0.35	19.00±0.58
February	6	5.00±0.45	4.00±0.32	4.00±0.45	9.00±0.35	22.00±0.80
	7	5.00±0.45	4.00±0.32	6.00±0.35	10.00±0.63	25.00±0.58
	8	5.00±0.45	4.00±0.32	8.00±0.35	10.00±0.63	27.00±0.66
	9	6.00±0.35	5.00±0.45	9.00±0.35	12.00±0.71	32.00±0.84
March	10	6.00±0.35	7.00±0.35	9.00±0.35	12.00±0.71	34.00±0.86
	11	7.00±0.35	7.00±0.35	10.00±0.63	14.00±0.71	38.00±0.71
	12	7.00±0.35	8.00±0.35	10.00±0.63	14.00±0.71	39.00±0.73
	13	8.00±0.35	8.00±0.35	11.00±0.45	16.00±	43.00±1.14
April	14	8.00±0.35	8.00±0.35	12.00±0.71	18.00±0.71	46.00±1.14
	15	8.00±0.35	8.00±0.35	12.00±0.45	18.00±	46.00±1.38
	16	8.00±0.35	7.00±0.35	10.00±0.63	18.00±0.71	43.00±0.58
	17	9.00±0.35	7.00±0.35	10.00±0.63	18.00±0.45	44.00±0.37
May	18	9.00±0.35	6.00±0.35	9.00±0.35	17.00±0.71	41.00±0.97
	19	9.00±0.35	6.00±0.35	10.00±0.63	17.00±0.71	42.00±1.05
	20	7.00±0.35	6.00±0.35	9.00±0.35	16.00±0.71	38.00±0.37
	21	7.00±0.35	5.00±0.32	10.00±0.63	16.00±0.45	38.00±0.49
	22	6.00±0.35	4.00±0.32	10.00±0.63	15.00±0.71	35.00±1.39
June	23	5.00±0.32	4.00±0.32	9.00±0.35	12.00±0.71	30.00±0.66
	24	4.00±0.32	5.00±0.32	9.00±0.35	10.00±0.63	28.00±0.86
	25	3.00±0.32	2.00±0.32	8.00±0.35	11.00±0.89	24.00±1.20
	26	3.00±0.32	3.00±0.32	8.00±0.35	10.00±0.63	24.00±0.97
July	27	3.00±0.32	4.00±0.32	9.00±0.35	12.00±0.71	28.00±0.86





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	28	6.00±0.35	6.00±0.35	9.00±0.35	14.00±0.71	35.00±0.86
	29	8.00±0.35	6.00±0.35	10.00±0.63	15.00±0.45	39.00±1.11
	30	7.00±0.35	6.00±0.35	11.00±0.45	16.00±0.71	40.00±1.39
August	31	7.00±0.35	7.00±0.35	12.00±0.71	17.00±0.71	43.00±1.67
	32	8.00±0.35	7.00±0.35	12.00±0.71	18.00±0.71	45.00±1.36
	33	8.00±0.45	6.00±0.35	13.00±0.71	18.00±0.71	45.00±1.20
	34	9.00±0.35	8.00±0.35	15.00±0.71	22.00±0.71	54.00±0.86
	35	9.00±0.35	8.00±0.35	15.00±0.71	20.00±0.71	52.00±1.24

Table 5. Population of Indian Peafowl *Pavo cristatus* at village Kandholi (Roopvas) during year 2021-22

Month	Standard Week	Sub Adult	Male	Male with Train	Female	Total
September	36	8.00±0.35	7.00±0.35	14.00±0.71	18.00±0.71	47.00±1.66
	37	8.00±0.35	8.00±0.45	14.00±0.71	18.00±0.71	48.00±1.83
	38	7.00±0.35	7.00±0.35	12.00±0.71	18.00±0.71	44.00±1.48
	39	7.00±0.35	7.00±0.35	12.00±0.71	17.00±0.71	43.00±1.38
October	40	6.00±0.32	6.00±0.32	12.00±0.71	16.00±0.71	40.00±1.67
	41	6.00±0.32	6.00±0.32	10.00±0.71	16.00±0.71	38.00±1.67
	42	5.00±0.32	5.00±0.32	10.00±0.55	15.00±0.71	35.00±1.76
	43	5.00±0.32	5.00±0.32	9.00±0.45	15.00±0.71	34.00±1.67
	44	4.00±0.32	5.00±0.32	9.00±0.45	15.00±0.71	33.00±1.22
November	45	5.00±0.45	4.00±0.32	8.00±0.35	16.00±0.71	33.00±0.92
	46	4.00±0.32	4.00±0.32	8.00±0.35	14.00±0.71	3.00±1.16
	47	4.00±0.32	5.00±0.32	8.00±0.35	14.00±0.71	31.00±1.24
	48	5.00±0.32	4.00±0.32	7.00±0.35	13.00±0.71	29.00±1.16
December	49	4.00±0.32	4.00±0.32	7.00±0.35	13.00±0.71	28.00±1.11
	50	4.00±0.32	4.00±0.32	7.00±0.35	12.00±0.71	27.00±1.02
	51	3.00±0.32	3.00±0.32	6.00±0.32	12.00±0.45	24.00±0.71
	52	3.00±0.32	3.00±0.32	6.00±0.32	10.00±0.45	22.00±0.71
January	1	3.00±0.32	2.00±0.32	6.00±0.32	10.00±0.55	21.00±0.77
	2	2.00±0.32	2.00±0.32	5.00±0.32	9.00±0.45	18.00±0.77
	3	2.00±0.32	1.00±0.32	4.00±0.32	8.00±0.35	15.00±0.97
	4	2.00±0.32	1.00±0.32	3.00±0.32	8.00±0.35	14.00±0.73
	5	3.00±0.32	1.00±0.32	4.00±0.32	8.00±0.35	16.00±0.58
February	6	4.00±0.32	2.00±0.32	6.00±0.32	10.00±0.35	22.00±0.71
	7	4.00±0.32	3.00±0.32	7.00±0.35	10.00±0.35	24.00±0.73
	8	5.00±0.32	3.00±0.32	7.00±0.35	9.00±0.55	24.00±0.73
	9	5.00±0.00±	4.00±0.32	8.00±0.35	10.00±0.71	27.00±1.11
March	10	6.00±0.32	4.00±0.32	8.00±0.35	11.00±0.71	29.00±0.73
	11	6.00±0.32	5.00±0.32	8.00±0.35	12.00±0.71	31.00±1.32
	12	7.00±0.35	6.00±0.32	9.00±0.45	12.00±0.71	34.00±1.20
	13	7.00±0.35	5.00±0.45	9.00±0.55	14.00±0.71	35.00±1.20
April	14	8.00±0.35	6.00±0.35	9.00±0.45	14.00±0.71	37.00±1.03
	15	7.00±0.35	6.00±0.32	8.00±0.35	16.00±0.71	37.00±1.11
	16	8.00±0.35	7.00±0.35	10.00±0.35	18.00±0.71	43.00±1.39
	17	7.00±0.35	6.00±0.32	12.00±0.71	17.00±0.71	42.00±1.66
May	18	7.00±0.35	6.00±0.32	12.00±0.71	16.00±0.71	41.00±1.66





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	19	6.00±0.32	5.00±0.32	10.00±0.55	16.00±0.71	37.00±1.22
	20	5.00±0.32	6.00±0.32	10.00±0.45	15.00±0.71	36.00±1.82
	21	5.00±0.32	5.00±0.32	9.00±0.45	14.00±0.71	33.00±1.45
	22	4.00±0.32	5.00±0.32	10.00±0.71	12.00±0.71	31.00±1.41
June	23	3.00±0.32	4.00±0.32	9.00±0.55	10.00±0.71	26.00±0.32
	24	2.00±0.32	3.00±0.32	8.00±0.35	12.00±0.71	25.00±0.97
	25	1.00±0.32	2.00±0.32	7.00±0.35	9.00±0.55	19.00±0.97
	26	2.00±0.32	2.00±0.32	7.00±0.35	8.00±0.35	19.00±1.07
July	27	2.00±0.32	4.00±0.32	8.00±0.35	13.00±0.71	27.00±0.97
	28	4.00±0.32	5.00±0.32	8.00±0.35	13.00±0.71	30.00±1.16
	29	5.00±0.32	6.00±0.32	9.00±0.45	15.00±0.55	35.00±1.14
	30	5.00±0.32	6.00±0.32	10.00±0.45	15.00±0.71	36.00±1.52
August	31	6.00±0.32	7.00±0.35	10.00±0.71	16.00±0.71	39.00±1.66
	32	6.00±0.32	7.00±0.35	11.00±0.71	16.00±0.71	40.00±1.66
	33	7.00±0.45	8.00±0.35	11.00±0.71	18.00±0.71	44.00±1.59
	34	8.00±0.35	8.00±0.45	12.00±0.71	22.00±0.71	50.00±1.85
	35	7.00±0.35	7.00±0.35	12.00±0.71	20.00±0.71	46.00±1.64

Table 6. Population of Indian Peafowl *Pavo cristatus* at village Kandholi (Roopvas) during year 2022-23

Month	Standard Week	Sub Adult	Male	Male with Train	Female	Total
September	36	7.00±0.35	7.00±0.55	13.00±0.45	17.00±0.71	44.00±1.32
	37	7.00±0.35	6.00±0.35	13.00±0.71	17.00±0.71	43.00±0.97
	38	7.00±0.35	6.00±0.35	13.00±0.71	16.00±0.45	42.00±0.66
	39	7.00±0.35	6.00±0.35	12.00±0.45	16.00±0.71	41.00±1.20
October	40	7.00±0.35	6.00±0.35	12.00±0.45	15.00±0.71	40.00±1.20
	41	6.00±0.35	7.00±0.35	11.00±0.45	15.00±0.45	39.00±0.58
	42	6.00±0.35	6.00±0.32	10.00±0.55	14.00±0.71	36.00±1.23
	43	6.00±0.35	5.00±0.32	10.00±0.55	14.00±0.71	35.00±1.56
November	44	6.00±0.35	5.00±0.32	9.00±0.55	14.00±0.71	34.00±1.59
	45	5.00±0.32	5.00±0.45	10.00±0.55	15.00±0.71	35.00±1.52
	46	6.00±0.35	4.00±0.32	9.00±0.55	13.00±0.71	32.00±1.20
	47	5.00±0.32	5.00±0.45	9.00±0.55	13.00±0.71	32.00±1.41
December	48	5.00±0.32	5.00±0.45	8.00±0.45	12.00±0.71	3.00±1.30
	49	4.00±0.32	5.00±0.32	9.00±0.45	12.00±0.71	3.00±0.55
	50	4.00±0.32	4.00±0.32	8.00±0.35	12.00±0.45	28.00±1.28
	51	3.00±0.32	3.00±0.32	8.00±0.35	11.00±0.45	25.00±1.07
January	52	3.00±0.32	2.00±0.32	7.00±0.35	10.00±0.55	22.00±0.58
	1	2.00±0.32	2.00±0.32	7.00±0.35	9.00±0.55	20.00±1.16
	2	2.00±0.32	1.00±0.32	5.00±0.55	9.00±0.55	17.00±1.14
	3	2.00±0.32	2.00±0.32	4.00±0.32	8.00±0.45	16.00±1.05
February	4	1.00±0.32	1.00±0.32	3.00±0.32	7.00±0.35	12.00±0.86
	5	2.00±0.32	1.00±0.32	4.00±0.32	7.00±0.35	14.00±1.02
	6	3.00±0.32	2.00±0.32	5.00±0.32	9.00±0.55	19.00±1.18
	7	3.00±0.32	3.00±0.32	6.00±0.35	9.00±0.55	21.00±0.97
	8	4.00±0.32	3.00±0.32	6.00±0.35	9.00±0.55	22.00±0.66
	9	4.00±0.32	4.00±0.32	7.00±0.35	9.00±0.55	24.00±0.73





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March	10	4.00±0.32	3.00±0.32	7.00±0.35	10.00±0.55	24.00±0.86
	11	5.00±0.32	4.00±0.32	8.00±0.35	11.00±0.45	28.00±1.07
	12	6.00±0.32	4.00±0.32	7.00±0.35	10.00±0.55	27.00±0.73
	13	6.00±0.35	5.00±0.32	8.00±0.35	12.00±0.71	31.00±0.81
April	14	7.00±0.35	5.00±0.32	8.00±0.35	13.00±0.63	33.00±1.39
	15	7.00±0.35	6.00±0.35	8.00±0.35	15.00±0.71	36.00±1.02
	16	8.00±0.35	6.00±0.35	9.00±0.55	15.00±0.71	38.00±1.17
	17	7.00±0.35	5.00±0.32	10.00±0.55	16.00±0.71	38.00±1.66
	18	6.00±0.32	5.00±0.32	10.00±0.55	15.00±0.71	36.00±1.38
May	19	6.00±0.35	5.00±0.32	9.00±0.55	15.00±0.71	35.00±1.24
	20	4.00±0.32	6.00±0.35	9.00±0.55	14.00±0.55	33.00±1.16
	21	4.00±0.32	5.00±0.32	8.00±0.35	14.00±0.71	31.00±1.23
	22	3.00±0.32	4.00±0.32	9.00±0.55	12.00±0.71	28.00±1.38
June	23	2.00±0.32	4.00±0.32	7.00±0.35	10.00±0.55	23.00±0.80
	24	1.00±0.32	3.00±0.32	6.00±0.35	8.00±0.35	18.00±0.68
	25	1.00±0.32	2.00±0.32	6.00±0.35	6.00±0.32	15.00±0.20
	26	2.00±0.32	2.00±0.32	5.00±0.32	6.00±0.35	15.00±0.37
July	27	2.00±0.32	4.00±0.32	7.00±0.35	12.00±0.71	25.00±1.20
	28	3.00±0.32	5.00±0.32	8.00±0.35	14.00±0.71	30.00±1.24
	29	4.00±0.32	6.00±0.35	10.00±0.55	14.00±0.55	34.00±0.97
	30	4.00±0.32	6.00±0.35	11.00±0.45	15.00±0.71	36.00±0.86
	31	5.00±0.32	7.00±0.35	11.00±0.45	15.00±0.71	38.00±1.07
August	32	6.00±0.35	7.00±0.35	10.00±0.55	16.00±0.71	39.00±1.39
	33	7.00±0.35	8.00±0.35	11.00±0.71	16.00±0.71	42.00±1.66
	34	8.00±0.35	9.00±0.55	10.00±0.55	17.00±0.71	44.00±1.85
	35	7.00±0.35	9.00±0.55	10.00±0.55	17.00±0.71	43.00±1.80

Table 7. Population of Indian Peafowl *Pavo cristatus* at Anirudh Nagar (Bharatpur) during year 2020-21

Month	Standard Week	Sub Adult	Male	Male with Train	Female	Total
September	36	8.00±0.35	7.00±0.32	14.00±0.71	20.00±0.71	49.00±1.50
	37	8.00±0.35	7.00±0.32	14.00±0.71	19.00±0.71	48.00±1.59
	38	7.00±0.32	7.00±0.45	13.00±0.71	18.00±0.71	45.00±1.14
	39	7.00±0.32	6.00±0.32	13.00±0.45	18.00±0.71	44.00±0.84
October	40	7.00±0.32	6.00±0.32	12.00±0.71	17.00±0.71	42.00±1.14
	41	6.00±0.32	6.00±0.32	12.00±0.71	17.00±0.71	41.00±1.64
	42	6.00±0.32	6.00±0.32	12.00±0.71	17.00±0.71	41.00±0.55
	43	6.00±0.32	5.00±0.32	11.00±0.71	17.00±0.45	39.00±1.14
November	44	6.00±0.32	5.00±0.32	11.00±0.63	16.00±0.71	38.00±0.32
	45	6.00±0.32	5.00±0.32	11.00±0.63	16.00±0.71	38.00±0.32
	46	5.00±0.32	5.00±0.32	10.00±0.71	15.00±0.71	35.00±1.30
	47	5.00±0.32	4.00±0.32	9.00±0.45	14.00±0.71	32.00±0.55
December	48	5.00±0.32	4.00±0.32	9.00±0.45	14.00±0.71	32.00±0.55
	49	5.00±0.32	4.00±0.32	9.00±0.45	14.00±0.71	32.00±1.14
	50	4.00±0.32	4.00±0.32	8.00±0.35	13.00±0.71	29.00±1.11
	51	4.00±0.32	3.00±0.32	8.00±0.35	12.00±0.71	27.00±1.20
	52	3.00±0.32	3.00±0.32	7.00±0.45	12.00±0.71	25.00±0.84





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January	1	3.00±0.32	3.00±0.32	7.00±0.45	12.00±0.71	25.00±1.18
	2	3.00±0.32	3.00±0.32	6.00±0.45	10.00±0.71	22.00±1.30
	3	2.00±0.32	3.00±0.32	6.00±0.45	9.00±0.45	20.00±1.18
	4	2.00±0.32	2.00±0.32	5.00±0.32	9.00±0.45	18.00±0.63
	5	3.00±0.32	2.00±0.32	3.00±0.32	10.00±0.71	18.00±0.71
February	6	5.00±0.32	4.00±0.32	7.00±0.45	9.00±0.32	25.00±1.00
	7	5.00±0.32	4.00±0.32	7.00±0.35	9.00±0.32	25.00±0.73
	8	5.00±0.32	4.00±0.32	7.00±0.55	10.00±0.71	26.00±0.45
	9	6.00±0.55	5.00±0.32	7.00±0.55	10.00±0.71	28.00±0.45
March	10	6.00±0.55	5.00±0.32	8.00±0.35	12.00±0.71	31.00±0.37
	11	8.00±0.35	6.00±0.55	8.00±0.35	13.00±0.71	35.00±1.05
	12	8.00±0.35	7.00±0.55	9.00±0.45	14.00±0.71	38.00±0.97
	13	9.00±0.45	9.00±0.45	8.00±0.35	15.00±0.71	41.00±1.36
April	14	9.00±0.45	9.00±0.45	8.00±0.35	14.00±0.71	40.00±1.36
	15	9.00±0.45	9.00±0.45	8.00±0.35	14.00±0.71	40.00±1.36
	16	10.00±0.71	10.00±0.71	9.00±0.45	15.00±0.55	44.00±1.14
	17	10.00±0.55	10.00±0.71	10.00±0.71	15.00±0.55	45.00±1.14
May	18	9.00±0.45	9.00±0.45	10.00±0.71	15.00±0.55	43.00±1.55
	19	9.00±0.32	10.00±0.71	9.00±0.45	14.00±0.71	42.00±1.58
	20	8.00±0.45	8.00±0.55	9.00±0.45	14.00±0.71	39.00±1.05
	21	7.00±0.32	7.00±0.55	10.00±0.71	13.00±0.63	37.00±0.84
	22	7.00±0.32	7.00±0.55	9.00±0.45	16.00±0.71	39.00±1.58
June	23	3.00±0.32	5.00±0.32	9.00±0.45	12.00±0.71	29.00±1.10
	24	3.00±0.32	4.00±0.32	8.00±0.35	10.00±0.71	25.00±0.97
	25	2.00±0.32	4.00±0.32	8.00±0.35	10.00±0.71	24.00±1.02
	26	2.00±0.32	3.00±0.32	7.00±0.55	10.00±0.71	22.00±1.26
July	27	2.00±0.32	4.00±0.32	8.00±0.35	11.00±0.71	25.00±0.66
	28	3.00±0.32	4.00±0.32	8.00±0.35	12.00±0.45	27.00±1.07
	29	4.00±0.32	5.00±0.32	9.00±0.45	14.00±0.71	32.00±1.10
	30	4.00±0.32	6.00±0.55	9.00±0.45	15.00±0.71	34.00±0.84
August	31	5.00±0.32	6.00±0.55	10.00±0.71	15.00±0.71	36.00±0.95
	32	6.00±0.55	6.00±0.55	12.00±0.55	18.00±0.71	42.00±0.63
	33	7.00±0.55	7.00±0.55	12.00±0.55	20.00±0.71	46.00±1.61
	34	7.00±0.55	7.00±0.55	12.00±0.55	21.00±0.71	47.00±1.48
	35	7.00±0.55	8.00±0.35	12.00±0.55	19.00±0.71	46.00±1.28

Table 8. Population of Indian Peafowl *Pavo cristatus* at Anirudh Nagar (Bharatpur) during year 2021-22

Month	Standard Week	Sub Adult	Male	Male with Train	Female	Total
September	36	7.00±0.32	8.00±0.45	12.00±0.45	16.00±0.71	43.00±1.52
	37	8.00±0.32	8.00±0.45	11.00±0.45	17.00±0.71	44.00±1.41
	38	6.00±0.32	6.00±0.35	10.00±	16.00±0.71	38.00±1.53
	39	6.00±0.32	5.00±0.32	8.00±0.45	14.00±0.71	33.00±1.48
October	40	5.00±0.32	6.00±0.32	8.00±0.45	14.00±0.71	33.00±1.00
	41	4.00±0.32	5.00±0.32	7.00±0.32	13.00±0.71	29.00±0.71
	42	5.00±0.32	4.00±0.32	8.00±0.145	13.00±0.71	30.00±1.05
	43	4.00±0.32	4.00±0.32	7.00±0.32	12.00±0.71	27.00±0.32





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	44	4.00±0.32	5.00±0.32	7.00±0.32	12.00±0.45	28.00±0.32
November	45	3.00±0.32	4.00±0.32	7.00±0.32	11.00±0.71	25.00±0.89
	46	3.00±0.32	5.00±0.32	8.00±0.45	10.00±0.45	26.00±0.89
	47	4.00±0.32	4.00±0.32	7.00±0.32	11.00±0.45	26.00±0.45
	48	3.00±0.32	4.00±0.32	7.00±0.32	11.00±0.45	25.00±0.55
December	49	3.00±0.32	3.00±0.32	6.00±0.32	10.00±0.45	22.00±0.84
	50	4.00±0.32	3.00±0.32	7.00±0.32	10.00±0.45	24.00±0.45
	51	3.00±0.32	4.00±0.32	6.00±0.32	11.00±	24.00±0.89
	52	4.00±0.32	3.00±0.32	6.00±0.32	10.00±0.45	23.00±0.84
January	1	3.00±0.32	2.00±0.32	5.00±0.32	10.00±0.45	20.00±0.55
	2	2.00±0.32	2.00±0.32	4.00±0.32	8.00±0.45	16.00±0.71
	3	1.00±0.32	2.00±0.32	4.00±0.32	9.00±0.32	16.00±0.55
	4	1.00±0.32	1.00±0.32	3.00±0.32	9.00±0.45	14.00±0.71
	5	2.00±0.32	2.00±0.32	2.00±0.32	10.00±0.45	16.00±0.71
February	6	4.00±0.32	3.00±0.32	6.00±0.32	8.00±0.45	21.00±0.63
	7	4.00±0.32	3.00±0.32	6.00±0.32	8.00±0.45	21.00±0.71
	8	4.00±0.32	3.00±0.32	6.00±0.32	9.00±0.45	22.00±0.95
	9	5.00±0.32	4.00±0.32	6.00±0.32	10.00±0.45	25.00±0.55
March	10	5.00±0.32	5.00±0.32	7.00±0.32	12.00±0.71	29.00±0.84
	11	5.00±0.32	5.00±0.32	6.00±0.32	12.00±0.45	28.00±1.05
	12	6.00±0.32	5.00±0.32	7.00±0.32	13.00±0.45	31.00±0.55
	13	6.00±0.35	6.00±0.32	7.00±0.32	12.00±0.55	31.00±1.11
April	14	6.00±0.35	6.00±0.32	8.00±0.45	14.00±0.63	34.00±1.36
	15	7.00±0.32	6.00±0.32	9.00±0.45	15.00±0.71	37.00±1.14
	16	7.00±0.32	7.00±0.35	9.00±0.45	16.00±0.55	39.00±1.02
	17	6.00±0.32	7.00±0.32	10.00±0.71	15.00±0.71	38.00±1.58
May	18	6.00±0.32	6.00±0.32	10.00±0.55	14.00±0.71	36.00±1.82
	19	5.00±0.32	6.00±0.32	9.00±0.45	14.00±0.84	34.00±1.48
	20	5.00±0.32	5.00±0.32	9.00±0.32	15.00±0.71	34.00±1.26
	21	5.00±0.32	5.00±0.32	10.00±0.55	13.00±0.71	33.00±1.05
	22	4.00±0.32	6.00±0.32	9.00±0.45	12.00±0.71	31.00±1.26
June	23	3.00±0.32	5.00±0.32	9.00±0.45	12.00±0.89	29.00±1.38
	24	3.00±0.32	4.00±0.32	8.00±0.45	10.00±0.89	25.00±1.10
	25	2.00±0.32	4.00±0.32	8.00±0.45	10.00±0.59	24.00±1.30
	26	2.00±0.32	3.00±0.32	7.00±0.32	11.00±0.71	23.00±1.22
July	27	2.00±0.32	4.00±0.32	8.00±0.45	12.00±0.45	26.00±0.89
	28	3.00±0.32	4.00±0.32	8.00±0.45	13.00±0.71	28.00±0.89
	29	4.00±0.32	5.00±0.32	9.00±0.45	14.00±0.71	32.00±1.48
	30	4.00±0.32	6.00±0.32	9.00±0.45	15.00±0.71	34.00±1.14
	31	5.00±0.32	6.00±0.32	10.00±0.89	16.00±0.71	37.00±1.00
August	32	6.00±0.35	6.00±0.32	12.00±0.71	18.00±0.55	42.00±1.77
	33	7.00±0.32	7.00±0.45	11.00±0.71	19.00±0.63	44.00±0.84
	34	7.00±0.32	6.00±0.32	10.00±0.89	2.00±0.95	43.00±0.89
	35	6.00±0.32	5.00±0.32	11.00±0.71	2.00±0.95	42.00±1.45

Table 9. Population of Indian Peafowl *Pavo cristatus* at Anirudh Nagar (Bharatpur) during year 2022-



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Month	Standard Week	Sub Adult	Male	Male with Train	Female	Total
September	36	6.00±0.27	5.00±0.45	11.00±0.71	19.00±0.71	41.00±0.97
	37	7.00±0.45	6.00±0.45	11.00±0.71	18.00±0.71	42.00±0.84
	38	6.00±0.45	5.00±0.45	10.00±0.45	16.00±0.71	37.00±0.89
	39	6.00±0.27	5.00±0.45	8.00±0.45	14.00±0.71	33.00±0.97
October	40	5.00±0.45	5.00±0.45	7.00±0.45	13.00±0.45	30.00±1.30
	41	5.00±0.45	4.00±0.45	7.00±0.45	12.00±0.71	28.00±1.38
	42	4.00±0.45	4.00±0.45	7.00±0.45	12.00±0.71	27.00±1.41
	43	4.00±0.45	3.00±0.45	8.00±0.45	10.00±0.71	25.00±1.14
	44	3.00±0.45	4.00±0.45	6.00±0.27	11.00±0.45	24.00±1.24
November	45	3.00±0.45	4.00±0.45	6.00±0.27	10.00±0.71	23.00±1.02
	46	3.00±0.45	3.00±0.45	6.00±0.27	10.00±0.71	22.00±1.02
	47	3.00±0.45	4.00±0.45	6.00±0.45	9.00±0.45	22.00±0.84
	48	2.00±0.45	3.00±0.45	5.00±0.45	9.00±0.45	19.00±0.95
December	49	3.00±0.45	3.00±0.45	5.00±0.45	8.00±0.45	19.00±1.14
	50	2.00±0.32	2.00±0.45	5.00±0.45	8.00±0.45	17.00±1.10
	51	2.00±0.32	2.00±0.45	4.00±0.45	7.00±0.45	15.00±0.45
	52	2.00±0.32	3.00±0.45	4.00±0.45	6.00±0.27	15.00±0.92
January	1	2.00±0.32	2.00±0.32	4.00±0.45	6.00±0.27	14.00±0.86
	2	1.00±0.32	1.00±0.32	3.00±0.45	5.00±0.45	10.00±0.32
	3	1.00±0.32	0.00±0.00	2.00±0.45	4.00±0.45	7.00±0.84
	4	0.00±0.00	1.00±0.32	0.00±0.00	5.00±0.45	6.00±0.32
	5	1.00±0.32	2.00±0.45	1.00±0.32	6.00±0.27	10.00±0.37
February	6	2.00±0.45	2.00±0.32	3.00±0.45	6.00±0.27	13.00±0.82
	7	2.00±0.45	2.00±0.32	3.00±0.45	7.00±0.45	14.00±0.89
	8	3.00±0.45	2.00±0.45	4.00±0.45	7.00±0.45	16.00±1.14
	9	3.00±0.45	3.00±0.45	4.00±0.45	8.00±0.45	18.00±1.30
March	10	4.00±0.45	3.00±0.45	4.00±0.45	8.00±0.45	19.00±1.30
	11	4.00±0.45	4.00±0.45	5.00±0.45	9.00±0.45	22.00±1.14
	12	5.00±0.45	4.00±0.45	6.00±0.27	9.00±0.45	24.00±0.97
	13	6.00±0.27	5.00±0.45	6.00±0.27	10.00±0.45	27.00±0.84
April	14	6.00±0.27	5.00±0.45	7.00±0.45	10.00±0.45	28.00±0.97
	15	5.00±0.45	6.00±0.27	7.00±0.45	11.00±0.45	29.00±1.39
	16	5.00±0.45	6.00±0.27	8.00±0.45	12.00±0.45	31.00±1.07
	17	5.00±0.45	6.00±0.27	8.00±0.45	14.00±0.71	33.00±1.46
	18	5.00±0.45	7.00±0.45	9.00±0.45	13.00±0.45	34.00±1.52
May	19	4.00±0.45	6.00±0.27	7.00±0.45	13.00±0.71	30.00±1.16
	20	4.00±0.45	5.00±0.45	7.00±0.45	12.00±0.00±	28.00±1.30
	21	3.00±0.45	5.00±0.45	6.00±0.27	8.00±0.45	22.00±0.97
	22	3.00±0.45	4.00±0.45	5.00±0.45	7.00±0.45	19.00±1.26
June	23	2.00±0.55	4.00±0.45	4.00±0.32	6.00±0.27	16.00±0.97
	24	2.00±0.45	2.00±0.45	2.00±0.32	5.00±0.45	11.00±0.71
	25	0.00±0.00	2.00±0.45	0.00±0.00	4.00±0.45	6.00±0.84
	26	2.00±0.45	0.00±0.00	3.00±0.45	6.00±0.27	11.00±0.49
July	27	3.00±0.45	2.00±0.45	5.00±0.45	8.00±0.45	18.00±1.05
	28	3.00±0.45	3.00±0.45	6.00±0.27	10.00±0.71	22.00±1.16
	29	4.00±0.45	4.00±0.45	7.00±0.45	12.00±0.45	27.00±1.14
	30	4.00±0.45	5.00±0.45	8.00±0.45	14.00±0.71	3.00±1.34



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	31	5.00±0.45	5.00±0.45	9.00±0.32	14.00±0.71	33.00±1.38
August	32	6.00±0.27	6.00±0.27	10.00±0.71	15.00±0.71	37.00±1.76
	33	5.00±0.45	6.00±0.27	10.00±0.71	16.00±0.71	37.00±1.77
	34	5.00±0.45	7.00±0.45	11.00±0.45	16.00±0.71	39.00±1.67
	35	6.00±0.27	6.00±0.27	10.00±0.45	15.00±0.45	37.00±0.95





Design and Analysis of an Expert System for Identification Types of Cancer

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ABSTRACT

Cancer in the broad-brimmed sense refers to more than 277 different types of cancer disease. Scientists have identified various stages of cancers, indicating that several gene mutations are involved in cancer pathogenesis. The effects of drugs on patients with cancer can predict and even manage some aspects of side effects. In this study, our motive was to review molecular aspects of cancer. With the help of various molecular methods, we are able to determine the strength of gene expression and defective proteins, as well as sleuthing novel biomarkers. Cancer stages are contraindicated by the numbers 0 through 4, which are often written as Roman numerals 0 through IV. Higher numbers indicate a more-advanced cancer. For some types of cancer, cancer stage is indicated using letters or words, that epigenetic abnormalities in cancer consists a multitude of aberrations in virtually every component of chromatin involved in packaging the human genome. Since epigenetic silencing processes are mitotically heritable, they can play the same roles and experience the same selective processes as genetic modification in the development of a cancer.





Keywords: Programming in logic, Artificial Intelligence, Expert System, Facts, Rules.

INTRODUCTION

In recent years, carcinogenesis performances have been detected by molecular genetic studies. The consequence of these studies led to an improved understanding of the role of genetic disorders in cancer formation. The full knowledge of the immune biology of cancer immune surveillance and immune editing will hopefully stimulate development of more impelling immunotherapeutic approaches to control or eliminate human cancers. For decades, scientists have been involved in dissecting the origins of human cancer, and the comparative roles of genetic versus epigenetic abnormalities have been hotly debated. A detonation of data indicating the importance of epigenetic processes, especially those resulting in the silencing of key regulatory genes, has led to the realization that genetics and epigenetic cooperate at all stages of cancer evolution. There are more than 100 types of cancer. Types of cancer are usually named after the organs or tissues where the cancers form. Before cancer cells signifies in tissues of the body, the cells go through abnormal changes called hyperplasia and dysplasia. In hyperplasia, there is an alteration in the number of cells in an organ or tissue that appear normal under a microscope. In dysplasia, the cells look anomalous under a microscope but are not cancer. Hyperplasia and dysplasia may or may not become cancer.

LITERATURE REVIEW

Liver Cancer -the incidence of hepatocellular carcinoma increases progressively with advancing age among populations, although it tends to level off in the oldest age groups. Patients with hepatocellular carcinoma are often unaware of its presence until the tumor reaches an advanced stage. The symptoms may include: the liver may rapidly enlarge, or a tumor may develop, or liver failure may occur. The reappearance of high serum globulin concentrations strongly suggests a diagnosis of hepatocellular carcinoma. Ultrasonography detects most hepatocellular carcinomas, but does not distinguish this tumor from other solid lesions in the liver. Approximately two-thirds of hepatocellular carcinomas are uniformly hyperechoic, with the remainder being partially hyperechoic and partially hypoechoic; small early tumors are hypoechoic. Mass screening of populations at high tumor risk is a challenging and costly task with relatively low yield. Long-term surveillance of individuals known to be at high risk (especially those chronically infected with hepatitis B or C) is more efficient and may be cost-effective. Ultrasound examination is used as an initial imaging screen in conjunction with measurement of serum α -fetoprotein levels, usually performed at 6-month intervals[1]. Bladder cancers occurring at a single site, the majority occurred on one of the bladder walls (40% on the lateral walls, 11% on the posterior wall, and 3% on the anterior wall). Less common subsites included the ureteral orifice (17%), followed by the trigone (13%), dome (9%), and neck (7%). Classic methods of diagnosing bladder neoplasms include cystoscopy (passing a tube through the urethra to examine the inner lining of the bladder), urine culture and cytology followed by transurethral biopsy/resection.

Histological analyzes of small tissue samples provide the diagnosis. Although many urinary markers have shown promise as diagnostic or screening tools for bladder cancer, none have yet been shown to be sufficient for the diagnosis or exclusion of bladder neoplasms. Screening procedures are currently not recommended for bladder cancer, even in high-risk groups, because of the high false-positive rate. Clinical trials of screening have not shown a beneficial effect on outcome or mortality[2]. Four population-based studies were designed to evaluate the effectiveness of colorectal cancer screening in more typical medical practice settings. The interest of the study conducted in Sweden (Kewenter, 1988) is limited because the screening test was only administered twice. The acceptability of the test at the first screening ranged between 53 and 67%; the positivity rate was 2.1% initially and 1.3% on average in subsequent rounds. Colorectal cancer mortality was significantly lower in the screening population compared with the control population (mortality ratio 0.82 to 0.86). The TNM (tumor, nodes, metastasis) system of the American Joint Committee on Cancer (AJCC) is currently recommended for the staging of colorectal cancer. It divides colorectal cancers into four stages depending on the depth of the primary "tumor", the presence



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and number of affected "nodes", and the presence of distant "metastases". TNM stage at diagnosis remains the best predictor of long-term prognosis for colorectal cancer. High radiations are passed in tubular form for a longer period in the treatment of such cancer[3]. Another promising new approach to cancer treatment is the use of monoclonal antibodies (mAb) to modulate the immune response and improve the body's ability to destroy cancer cells. However, to date, the use of anti-4-1BB mAbs such as urelumab has been limited due to intolerable side effects. The international team reengineered the 4-1BB molecule to create a recombinant antibody called trimer body that had potent stimulatory activity without associated toxicity. As part of their research, they used high-angle small-angle X-ray scattering (SAXS) on the B21 beam. This new approach may unlock the potential of immunotherapeutic antibodies in cancer treatment with minimal side effects[4]. The application of data mining techniques in the case of ovarian cancer. Ovarian cancer is the second leading cause of death among gynecological cancers in the world. Five data mining classification techniques, including support vector machine (SVM), C5.0, extreme learning machine (ELM), multivariate adaptive regression splines (MARS were used to achieve this goal), and random forest (RF). The Importance of Data Mining to Extract Hidden Knowledge from Multiple Heterogeneous Cancer Datasets. It presents methods, techniques, and tools that can help solve cancer diagnostic and prognostic problems of ovarian cancer through new diagnostic method such as the tubuler method[5].

Minor increases have been reported for malignant brain tumors which are listed since 1979, when the National Center for Health Statistics implemented a new format for reporting mortality data. The problem is the lack of substantial improvement over what treatment has been able to achieve for decades before. Improving diagnosis in health care requires a significant re-envisioning of the diagnostic procedures and widespread commitment to modification. A national commitment to cancer prevention that largely replaces reliance with the promise to a universal cure is now a long way to go. The evidence includes large and ongoing reductions in smoking, large-scale individual dietary change efforts to prevent cancer, and the use of sunscreens to reduce sun exposure. The death rate in 1994 was 2.7 percent higher than in 1982, the last year reported in 1986, but the recent decline is likely to be confirmed and substantially extended as a result of better prevention and earlier detection. and especially past reductions in tobacco use[6]. The study to investigate the protective effect of thyroid against gastric further reveal the mechanism involved through the integration of network pharmacology and in vivo experimental evidence. Due to the complexity of the etiology and pathogenesis of thyroid, there is no unified and effective treatment plan in Western medicine. Recent years have shown that traditional Chinese medicine has evolved in treating thyroid cancer and preventing its further progression to gastric cancer, relying on multi-access and multi-target encompassing intervention characteristics further to broader aspects. These results conveys that thyroid stopped the perpetual progression of gastric through the inhibition of epithelial-mesenchymal transmutation process[7].

Gastric carcinomas composed of well-differentiated and poorly differentiated components show some, but not all, of the molecular events previously described for each of the two types of gastric cancer. In addition to these genetic and epigenetic phenomena, well-differentiated and poorly differentiated gastric cancers also organize different patterns of interplay between cancer cells and stromal cells through the growth factor/cytokine receptor system, which plays an important role in cell growth, apoptosis, morphogenesis, angiogenesis, progression and metastasis[8]. Due to the relatively low incidence and poor survival of pancreatic cancer, risk factors associated with the development of this disease have historically been investigated using case-control studies. Unfortunately, these study designs have weaknesses, including selection bias and recall bias. To overcome the problems of sample size in prospective studies, the pooling of data by consortia from multiple cohort studies, which have been published more frequently in recent years, is needed. Investigation of potential biomarkers including liquid biopsy to aid in the screening, diagnosis and treatment of pancreatic cancer is an area of intense research. All have been investigated in efforts to detect biomarkers in blood, breath and pancreatic juice. Pancreatic intraepithelial neoplasia is a non-invasive microscopic lesion that occurs in small pancreatic ducts. Currently, surgical resection is the only potential cure for pancreatic cancer, although recurrence rates are high with inevitably dismal long-term survival rates[9]. The first step in evaluating patients for skin cancer includes a thorough history focusing on general medical and drug history, personal and family history of skin cancer, number of birthmarks including presence of dysplastic nail, and comprehensive social history, carcinogen or sun exposure. Curettage and electrodesiccation, cryosurgery, local



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chemotherapy, laser surgery, radiotherapy, immunotherapy. Primary radiotherapy is considered to treat skin cancer involving the nose, lower eyelids or ears. A limitation for radiotherapy is the lack of histological control of margins and errors, which often leads to under treatment or overtreatment. It is not clear whether using combinations of drugs is more helpful than using a single drug, but it may add to side effects such as hair loss, mouth ulcers, loss of appetite, nausea and vomiting, diarrhea, increased risk of infection, easy bruising or bleeding, fatigue. Dermoscopic examination of individual lesions allows visualization of deeper layers of the skin and can be useful in the hands of experts[10]. Findings of literature study are that an expert system could be designed for prognosis and diagnosis for assisting patient based on their symptoms.

METHODOLOGY

A logical programming language is PROLOG. It is crucial for artificial intelligence. PROLOG is primarily designed to be a declarative programming language, in contrast to many other programming languages. Logic is expressed as relationships in PROLOG (called facts and rules). The logic employed forms the basis of PROLOG. In the Prologue, certain information is presented. The system's knowledge base is comprised of this information. Facts in the prologue are presented in a certain way. Entities and their relationships are contained in facts. Comma-separated parenthesis is used to indicate entities (.). The commencement and the space between the parenthesis describe their relationship. A period follows each fact or rule (.). The logical variables that make up PROLOG features conform to a standard data structure. The terms "mathematical variable," "pattern-matching facility," "input and output" and "backtracking approach to investigate for proofs" are interchangeable. Instead of using software, the user asks a query to obtain the answer. The run-time system looks through the database of facts and rules to get the answer when the user asks a question; the working of the inference engine is shown in figure 1. On the same note, it is also feasible to design research that will provide the desired outcomes, particularly when these studies are much abstracted from the context of the entire body and the entire environment. In our study, we demonstrated that, under specific circumstances, we were able to demonstrate a full-proof outcome. A consistent characterization of population disposition of factors associated to the prevention, early detection, or treatment of cancer is presented in the Cancer Trends Progress Report using statistical techniques. At first the user will type "do.+enter", and with this the AIDr will start. Then the user will be asked a few questions about their symptoms, like what kind of symptoms are they having, the user will type "y.+enter" or "n.+enter" to choose if they are having that particular symptom or not then the system will check the database that what kind of cancer has similar symptoms. after matching the symptoms with the user, the system will show the cancer of that particular type.

Experimentation

The hypothesis to be tested based on the symptom's verification. In this regard, the disease cancer type is taken as hypothesis and the symptoms of this type of cancer taken as verifiable, which need to be verified to support the hypothesis; and hence the table 1 is designed accordingly.

RESULTS AND DISCUSSION

The diagnosis is advised by the so called AIDr (AI Doctor)[31] as an expert system which has been proposed. The experimentation carried out with Programming in logic (PROLOG) and the results are shown in the following figure 2, 3, 4. As we are progressing towards new technological advancements, we are unable to financially approve the latest equipment as there is always a new and better version of the current provided equipment we have, which may dissuade some patients from visiting us. Providing different specialties under one hospital like medical oncology, radiation oncology, surgical oncology, physical therapy and others. Several competitors are beginning to poach our patients by promising better treatment options or by rendering them with special facilities. Scientists are hiring more providers who have specialized backgrounds to be able to treat rarer and more invasive types of cancer.



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CONCLUSIONS

The science of data management uses all of its resources and makes the most effort to develop methods and techniques to use these data, with medical diagnostic reasoning being a very important application area of intelligent systems, in order to deal with the massive flow of biomedical data produced day after day and make important and valuable hidden knowledge inside. We can assess the level of gene expression, identify malfunctioning proteins, and find new cancer biomarkers by using a variety of molecular techniques and the suggested expert system. These results may aid in the treatment of cancer and raising public awareness of its complications. Additionally, a number of studies are currently being conducted to look into epigenetic mechanisms and how they relate to the onset and progression of many diseases, particularly cancer. However, identifying all the symptoms and AIDr advices, give us a comprehensive map for further efforts to identify cancer in the future and draw awareness in the society.

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Table 1 Knowledge Base of the Expert System

Disease/Cancertype/Hypothesis	Symptoms
[11]Skin Cancer	<ul style="list-style-type: none"> ✓ Non-healing sore that bleeds ✓ Scar growth ✓ Red patches ✓ Swelled like mole
[12]Lung Cancer	<ul style="list-style-type: none"> ✓ Hoarseness



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	<ul style="list-style-type: none"> ✓ Weight loss ✓ Infections such as bronchitis ✓ Wheezing
[13]Bladder Cancer	<ul style="list-style-type: none"> ✓ Weakness ✓ Bone pain ✓ Loss of appetite ✓ Swelling in the feet
[14]Blood Cancer	<ul style="list-style-type: none"> ✓ Fever ✓ Itchy skin ✓ Chest Pain ✓ Shortness of breath
[15]Pancreatic Cancer	<ul style="list-style-type: none"> ✓ Nausea ✓ Bloating ✓ Abdominal Pain ✓ Jaundice
[16]Thyroid Cancer	<ul style="list-style-type: none"> ✓ Difficulty swallowing ✓ Pain in neck and throat ✓ Lymph nodes in the neck ✓ May affect lungs and bones ✓ Change in voice
[17]Liver Cancer	<ul style="list-style-type: none"> ✓ Unusual tiredness ✓ nausea ✓ Loss of appetite ✓ jaundice ✓ Swollen abdomen
[18]Kidney Cancer	<ul style="list-style-type: none"> ✓ Fever ✓ tiredness ✓ Blood in urine ✓ Pain in back ✓ Weight loss
[19]Breast Cancer	<ul style="list-style-type: none"> ✓ redness ✓ Swollen lymph nodes ✓ irritation ✓ discomfort ✓ Breast pain
[20]Ovarian Cancer	<ul style="list-style-type: none"> ✓ Abdominal bloating ✓ Weight loss ✓ Frequent urination ✓ Back pain ✓ Fatigue
[21]Colorectal Cancer	<ul style="list-style-type: none"> ✓ Rectal bleeding ✓ constipation ✓ Abdominal discomfort ✓ Change in habits ✓ Fatigue
[22]Head and Neck Cancer	<ul style="list-style-type: none"> ✓ Red patch in mouth ✓ Sore throat ✓ Double vision ✓ Difficulty breathing

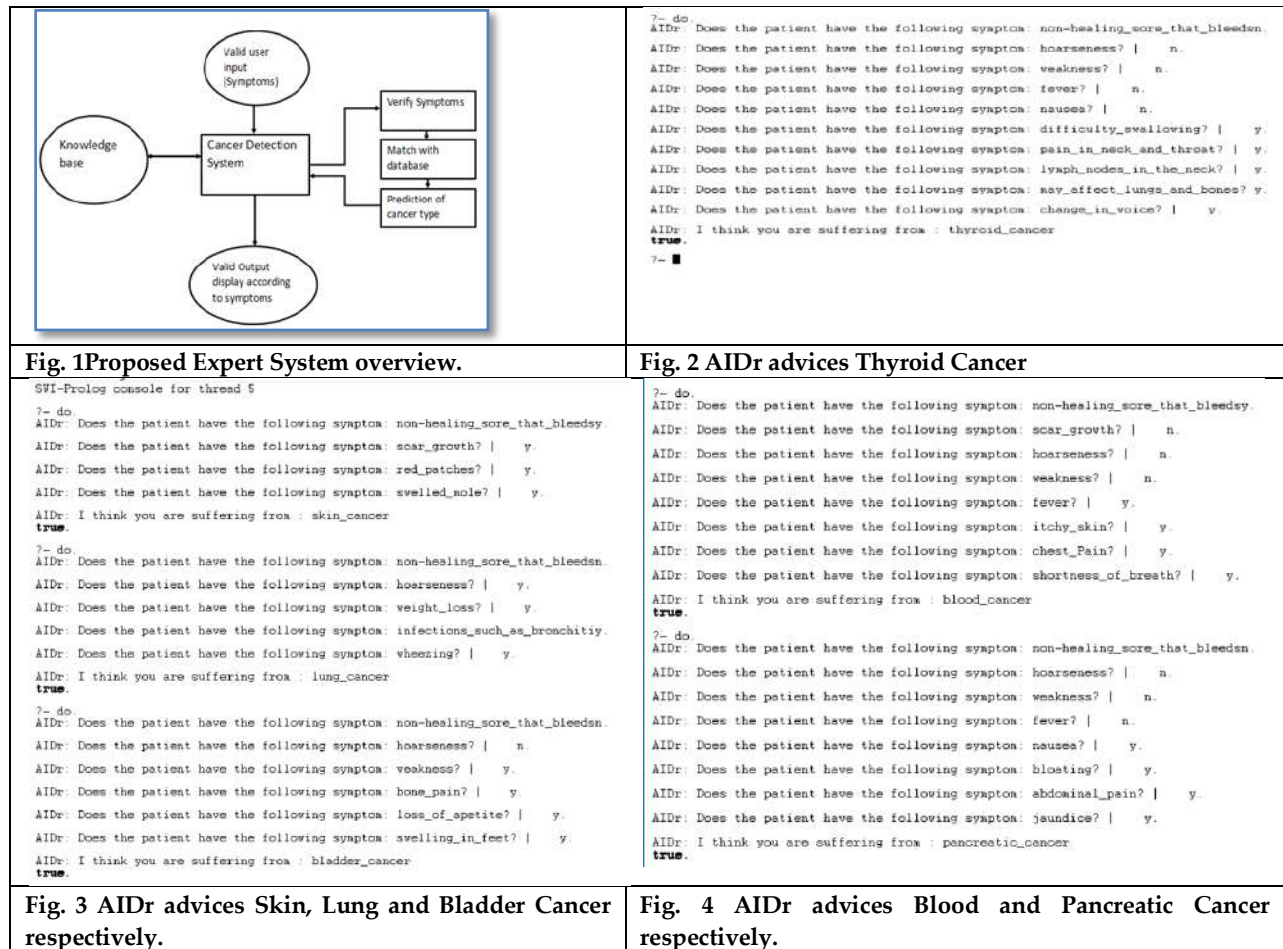




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	✓ Jaw pain
[23]Prostate Cancer	✓ Pain in back ✓ Urinating often ✓ Abdominal discomfort ✓ Change in habits ✓ Pain in pelvic
[24]Endometrial Cancer	✓ Abnormal discharge ✓ Weight loss ✓ Abdominal discomfort ✓ Back pain ✓ Unusual bleeding
[25]Uterine Cancer	✓ Rectal bleeding ✓ Pain in abdomen ✓ Abdominal discomfort ✓ Urination problem ✓ Bleeding
[26]Penile Cancer	✓ Change in skin colour ✓ ulcer ✓ Smelly discharge ✓ Area of skin becomes thicker ✓ Formation of lump
[27]Salivary Gland Cancer	✓ Numbness in face ✓ Trouble swallowing ✓ Weak muscles ✓ Pain in jaw mouth ✓ Difference in size of face
[28]Cervical Cancer	✓ Pain in the pelvic ✓ Swelling of legs ✓ Blood in urine ✓ Pain in back ✓ Abnormal bleeding
[29]Brain Cancer	✓ Memory lapses ✓ Difficulty thinking ✓ nausea ✓ Muscle jerking ✓ Vision problem
[30]Parathyroid Cancer	✓ Lump in the neck ✓ Pain in neck ✓ Pain in back ✓ Blood in urine ✓ Constipation







Spectroscopic Elucidation and Biological Evaluation of Cu²⁺ and Mn²⁺ Metal Complexes Derived from Azomethine Ligand

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ABSTRACT

The synthesis and characterization of a novel Schiff base ligand, along with its solid metal complexes formed from the combination of 3-methoxysalicylaldehyde and p-methylbenzohydrazide (HL), were meticulously conducted using a modified Sandmeyer's method. Remarkably, these synthesized complexes displayed distinctive colors upon interaction with Cu²⁺ and Mn²⁺ ions in conjunction with HL. To elucidate the structures of these innovative azomethine compounds, a comprehensive array of analytical techniques was employed, encompassing FT-IR, UV-Vis Spectrometry, elemental analysis, ¹H-NMR, TG-DTA, ESR, Conductometric measurements and Vibrational spin magnetometry. Furthermore, the compounds underwent a rigorous assessment of their biological activity, revealing a noteworthy inhibitory effect against pathogenic microorganisms. Specifically, *Salmonella typhi*, *Enterococcus faecalis*, and *Escherichia coli* were targeted, and the compounds exhibited significant antimicrobial potential against these organisms. This outcome underscores the promising biological activities of the synthesized compounds, positioning them as potential candidates for further exploration and development in the realm of antimicrobial agents. Through a meticulously designed research endeavor, the study contributes



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to both the understanding of novel compound synthesis and their potential application in addressing bacterial infections.

Keywords: Synthesis, Characterization, Azomethine, Biological activity

INTRODUCTION

The investigation into Schiff base complexes involving a range of transition metal ions has yielded insights into their biological functionalities, pharmaceutical attributes, and coordination capabilities [1-3]. These intricate compounds have been used as photolysis catalysts [4] and to facilitate oxygen reduction on modified carbon cathodes [5]. Schiff base derivatives have shown useful in the biological extraction of metals [6], as well as in industries such as the paint industry and medicinal bioinorganic domains [7-9]. Furthermore, several molecules have found application in industrial settings as well as in the catalytic hydrogenation of unsaturated hydrocarbons [10]. Moreover, Schiff base have demonstrated utility in analytical contexts [11] for the identification of metal ions, showcasing their versatility. The practical applications of such complexes are intricately linked to their molecular structures. In this particular study, the author presents a fresh series of metal complexes involving Cu^{2+} and Mn^{2+} ions, forming complexes with a Schiff base (HL) ligand prepared from the p-methylbenzohydrazide and 3-methoxysalicylaldehyde. The characterization of those complexes has been achieved through diverse means, including vibrational spin magnetometry, FT-IR, UV-Vis Spectrometry, elemental analysis, ESR, ^1H -NMR, Thermo gravimetric Analysis-Differential Thermal Analysis (TGA-DTA), and Conductometric measurements. These techniques collectively contribute to determining the bonding mode and geometric arrangements of the complexes. Furthermore, the study delves into the biological activities of both the ligand and the resulting metal complexes.

Materials and Methods

Instrumentation and Materials

A Fison: EA1108 element analyzer was used for the elemental analysis (CHNO). The FT-IR was obtained by making KBr discs and using an FT-IR-5300: JASCO instrument. An ACF200 Broker Germany Spectrometer was used to record ^1H NMR spectra at a frequency of 400Hz. A Prekin-Elmer lab India UV-Vis Spectrometer was used to collect ultraviolet spectra. The JES-FA Series device was used to collect an ESR spectrum. The PA:SPTQ600 instrument was used to obtain a thermal gravimetric analysis spectrum. Complex metal Thermo gravimetric analysis were carried out using the Perkin Elmer equipment located in the thermal analysis centre, with ethyl alcohol and sticko chin as solvents. Only Aldrich compounds were used throughout the study.

Synthesis of p-methylbenzohydrazide and 3-methoxysalicylaldehyde Schiff base (HL)

To synthesize the Schiff base ligand (HL), 1.50g (1 mole) of p-methylbenzohydrazide and 1.52g (1 mole) of 3-methoxysalicylaldehyde was dissolved in 25ml of pure methanol. This mixture was placed in a 50ml round bottom flask along with 1 ml triethylamine solution added. The resulting mixtures were subjected to reflux for duration of 3 hours using a water hot bath. Subsequently, the mixtures were allowed in to cool down to room temperature. During this process, distinct yellow-colored sharp needles precipitated out of the solution. These precipitates were then isolated and subjected to washing with methanol. Afterward, they were dried within the vacuum desiccators contain anhydrous CaCl_2 [12-13]. Scheme 1 shows the synthetic method of prepared the Schiff base (HL).



**Preparation of Schiff base metal complexes (M₁L and M₂L)**

To prepare the metal complexes, Cu²⁺ and Mn²⁺ metal chloride salts were utilized. Initially, 3.0g (equivalent to 2 moles) of the freshly synthesized ligand were dissolved in a sufficient quantity of methanol. The metal complexes were prepared in a 1:2 ratio. An aqueous solution comprising 6.655g (1 mole) of metal chloride for one complex and 6.656g (1 mole) of metal chloride for the other complex was added to this solution, along with 1 ml of hydrochloric acid (HCl). The resultant mixture was refluxed for duration of 6 hours using a water bath. After the reflux process, allow the mixture to cool to room temperature. During this cooling process, distinct black, green, and pale yellow-colored sharp needle-like crystals precipitated out. Subsequently, these color metal complexes were isolated, washed sequentially with methanol and water, followed by recrystallization from ether. The crystals were then derided within a vacuum desiccator containing anhydrous CaCl₂. For characterization purposes, elemental analysis were conducted for both the newly prepared HL ligand and its metal (M₁L and M₂L) complexes. The Schiff base HL and its corresponding metal complexes (M₁L and M₂L) were subjected to analytical assessments, and the obtained data were organized in Table 1.

RESULT AND DISCUSSION**FT-IR spectra of HL ligand, M₁L and M₂L complexes**

Table 2 sheds light on the observations made during the analysis of FT-IR spectrum of both the, and that of the M₁L and M₂L complexes. The distinctive FT-IR spectrums are visually represented in Figures 1, 2 and 3. A comparison was drawn between the FT-IR spectrum of the HL and that of the M₁L and M₂L complexes. Resulting data were compiled in a tabular format, including corresponding assignments. The FT-IR spectra of the HL revealed a board peak band at 1646 cm⁻¹ [14], which was attributed to the Schiff base group is $\nu_{C=N}$ stretching. Notably, in the complexes, that band were displaced to lower regions at 1606 cm⁻¹ and 1620 cm⁻¹[15], respectively, for M₁L and M₂L. This shift suggested that the Schiff base group $>C=N$ was involved in complexation, most likely due to a decrease in electron density on the nitrogen atom. This modification implied that the metal was coordinated through the nitrogen atoms. The disappearance of the $\nu_{(OH)}$ bond [16] at 3555 cm⁻¹ in the FT-IR spectrum of the metal chelates showed proton displacement from that of phenolic group during complexation. This observation pointed to the bonding of the metal ions with the ligand via a covalent linkage involving the oxygen in the phenolic group. Additionally, in the FT-IR spectrum of M₁L, M₂L complexes, and there was a broad peak bands [17] around 3425 cm⁻¹ to 3380 cm⁻¹respectively emerged, which could be attributed to OH stretching vibrations associated with water (H₂O) molecules participating in complexes formation. Presence of two weak peak bands appeared at 812.5 cm⁻¹ to 798.2 cm⁻¹ indicated the hydroxyl group wagging and rocking vibrations of coordinate water molecule. Distinctive the bands emerged in the M₁La nd M₂L complexes, absent in the HL. This band at 460 cm⁻¹ and 470 cm⁻¹ was associated with stretching of ν_{M-O} , while bands at 736 cm⁻¹ and 738 cm⁻¹ [18] corresponded to the frequencies of stretching of ν_{M-N} [19-21].

¹H NMR spectra of HL and their M₁L, M₂L metal complexes

The ¹H NMR spectrum of the HL and the M₁L, M₂L metal complexes were recorded in DMSO-D₆ as the solvent, and these spectra are presented in Figures 4, 5, and 6. Table 3 shows the chemical shift values for both the HL and M₁L, M₂L metal complexes. For the ligand HL, a singlet peak appears at 2.37 ppm [21], corresponding to the proton bond to the Schiff base group. Upon complexed, this peak shifts to lower field, specifically at 2.26 ppm for M₁L and 2.29 ppm for M₂L complexes. Such a shift indicate that the shielding effect on the Schiff base group. Notably, the phenolic proton [22] has a singlet signal at 11.52 ppm that disappears in complexes. The signal corresponding to the Schiff base protons moves from 2.37 ppm to 2.26 ppm and 2.29 ppm in the ¹H NMR spectra of the M₁L and M₂L complexes, respectively. This change emphasises the Schiff base groups shielding action. Furthermore, when compared to the equivalent Azomethine spectra, the aromatic ring proton, which is generally found in the 7.20-7.30 ppm region [22], becomes broader and less prominent. The aromatic ring protons at 7.20-7.30 ppm grow broader and less intense in the complex than in the Schiff base. Additionally, the appearance of a peak at 2.82 ppm in the ¹H NMR spectrum of the metal complexes M₁L and M₂L as suggests that the coordination of water molecules through interaction with the metal ion.



**Nageswara Reddy Gosu et al.,****Conductance for M₁L and M₂L complexes**

The M₁L and M₂L complexes molar conductance when dissolved in dimethylformamide at a concentration of roughly 10⁻³ M, was determined at a temperature of 27±2°C used a Systronic-303 reading conductivity meter. To conduct this test, a measured quantity of solid complexes were transferred into a standard 25 ml borosil flask and, then dissolved in dimethylformamide. The solutions were brought to the flask marked level using DMF. Subsequently, the M₁L and M₂L complexes solution was transferred into a dry and clean 100 ml beaker flask. The molar conductance's of these complex was found to be less than the 21 ohm⁻¹ cm² mol⁻¹, which indicates their non-electrolytic in nature. This implies that the complexes do not dissociate into ions when dissolved in the solvent. Table 4 summarises the molar conductances values of M₁L and M₂L complexes.

UV-Vis spectral data of HL and their M₁L, M₂L complexes

The electronic spectrum of the HL and their corresponding M₁L, M₂L complexes have been provided, with their respective transitions detailed in Table 5. For the ligand, a distinctive signal band appears at 283 nm, attribute to the transition $\pi-\pi^*$. Upon complexation, this band experiences a shift towards higher wavelength regions. Additionally, novel bands arise in the complexes, indicative of charge transfer transitions. Notably, d-d transitions may be seen in the visible area of the complexes higher concentration spectrum.

ESR spectra of M₁L and M₂L complexes

The Electronic spin resonance spectrum of the complexes in their polycrystalline state display a single broad peak signal, attributed to dipolar broadening and an enhanced spin-lattice relaxation effect. Anisotropic spectra obtained for these complexes in DMF at low nitrogen temperature (LNT) have been presented in Figure 7 and 8. Four minor intensity peaks have been observed within this low-temperature spectrum, which are thought to be caused by the g_{\parallel} component. Table 6 shows the spin Hamiltonian, orbital reduction, and bonding parameters for the M₁L and M₂L complexes. The values of g^{\perp} and g_{\parallel} are computed from this spectra using the 2,2-diphenyl-1-picrylhydrazyl free radical as a g marker. According to Neiman and Kvelson [23], g values less than 2.30 imply covalent bond character, whereas values more than 2.30 indicate ionic bond character of the M-L bond in complexes. Using this criterion, the presence of covalent bond character between the M and L complexes can be inferred [24]. The pattern of $g > g > 2.0023$ found for the complex shows that the unpaired electron localises within the complex in the dz^2 and dx^2-y^2 orbital of the Cu²⁺ ions. It is worth noting that the G for these M₁L and M₂L complexes is more than 4, showing that interactions between M-M centre do not exist in the DMF medium.

ESR parameters such as $A^{\perp*}$, A_{\parallel}^* , g^{\perp} , and g_{\parallel} , as well as d-d transition energies, contribute to bonding parameters (α^2), evaluating orbital reduction parameters (K^{\perp} , K_{\parallel}), and dipolar interactions (P) [25]. The presence of out-of-plane π -bonding is indicated by the observed connection of $K^{\perp} > K_{\parallel}$. The present chelates α^2 values, which range from 0.410 to 0.480, support the covalent character of these complexes. The method proposed by Giordano and Bereman involves obtaining bonding group information from dipolar term P values. A decrease in P values from the ion value (0.0360 cm⁻¹) indicates strong covalent bonding. The P values found for the current complexes, which range from 0.0290 to 0.0310 cm⁻¹, are compatible with metal ion bonding to oxygen and nitrogen donor atoms, respectively. The form of the ESR spectra, together with electronic spectrum data and ESR, suggests that these complexes have an octahedral geometry [26].

Magnetic moment of M₁L and M₂L complexes

Magnetic susceptibility value of that M₁L complex at room temperature align within the range of 1.76 BM, as presented in Table 7. At ambient temperature, these results indicate significant orbital contributions and effective magnetic susceptibility in octahedral compounds. Magnetic susceptibility for low-spin octahedral complexes often exceeds 1.76 B.M in magnetically dilute substances. The magnetic characteristics of the Mn²⁺ complex provide information on its shape. In the M₂L complex, magnetic susceptibility value measures 5.44 B.M [27]. Remarkably, the magnetic susceptibility of the M₂L complex closely approach the spin-only value.



**Nageswara Reddy Gosu et al.,****TGA-DTA spectra of M₁L and M₂L complexes**

The thermo gravimetric analysis data for the M₁L and M₂L complexes have been compiled in the Table 8. Representative thermo grams are depicted in Figures 9 and 10. These complexes exhibit stability up to temperature range from 800°C to 900°C. Decomposition process transpires in two stages. The initial stage of decomposition, occurring in the temperature ranges of 90°C to 175°C, involves the endothermic loss of H₂O molecules, leading to the formation of anhydrous intermediates [28]. Subsequently, the second stage of decomposition takes place, manifested by the decomposition of the intermediates. This stage shows two exothermic peaks within the temperature range of 270°C to 310°C [29-30]. At elevated temperatures, the corresponding metal oxides are formed as stable end products. The estimated weights were compared to the experimental percentage mass loss. According to the thermal gravimetric data, the complexes exhibited a stability order of M₂L > M₁L. This provides insights into relative thermal stability of the complexes, with the M₂L complex demonstrating higher stability compared to the M₁L complex.

Biological activity

In the course of this present investigation, the author embarked on evaluating the antibacterial studies of the HL and its corresponding M₁L and M₂L complexes against *E. coli*, *E. faecalis*, and *S. typhi*. This was accomplished using the serial paper disc method, with the results tabulated in Table 9. The biological studies assessment of the M₁L and M₂L complexes underscore several key observations. A compared analysis of the HL and its M₁L, M₂L complexes reveals the M chelate exhibit elevated antibacterial studies compared to the free HL. Intensified antibacterial studies of the M chelates can be attributed to impact of the metal ion. This phenomenon can be explain through overtone the chelation theory and the concept theory. Due to the overlapping HL orbital and the partial shared of positive charges from the metal M ion with donor groups during chelation, the polarity of the M ion is significantly reduced. Furthermore, it was noted that delocalization of π across the entire chelates ring augments lipophilicity of the complexes. Heightened lipophilicities [31] facilitates the penetration of the M₁L and M₂L complexes into lipid membranes, effectively obstructing the metal sites on microorganism enzymes. The zone of inhibition for the M-L complex has been documented in the Table 9, encapsulating the inhibitory effects observed against the tested microorganisms.

CONCLUSION

The outcomes of the aforementioned study yield several significant conclusions. It can be deduced that the Schiff base formed through the reaction of 3-methoxysalicylaldehyde with the alkylamine, specifically p-methylbenzohydrazide, serves a highly effective complexed agent for a range of transition metal ions. The bidentate nature of the ligand during complexation has been discerned through the comprehensive spectral investigations carried out. Remarkably, all the metal complexes display a neutral charge and exhibit noteworthy thermal stability. It is worth noting that predicting the ultimate structures of the complexes is a complex task, and no single technique can be solely relied upon for this purpose. Instead, a combination of various spectral and analytical methods is essential to provide a comprehensive understanding of the structural characteristics of these complexes.

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**Table 1: Analytical data of the HL and M₁L, M₂L metal complexes.**

			HL	M ₁ L	M ₂ L
Molecular weight			284.34	665.53	656.939
Co lour			Yellow	Black Green	Pale Yellow
Yield			76	73	68
M.P			182-184	292-294	320-322
Elemental Analysis	C %	Calculated	67.53	57.68	58.44
		Found	67.47	57.60	57.90
	H%	Calculated	5.61	5.11	5.18
		Found	5.91	4.99	5.30
	N %	Calculated	9.83	8.40	8.51
		Found	9.72	8.03	8.72
	O%	Calculated	16.87	19.22	19.47
		Found	16.31	19.10	19.55
	M%	Calculated	-	9.53	8.35
		Found	-	9.51	8.31

Table 2: The important FT-IR bands of the HL ligand and its metal complexes

Compound	OH(Water)	ν_{OH} (Phenolic)	$\nu_{C=N}$	ν_{Ar-H}	ν_{M-O}	ν_{M-N}	ν_{C-H}
HL	-	3555	1646	3068	-	-	2844
M ₁ L	3425	-	1606	3032	470	736	2837
M ₂ L	3381	-	1620	3061	460	738	2843

Table-3: ¹H NMR Spectrum of the ligands and its metal complexes in DMSO-d₆ in ppm

Compound	H-C=N	CH ₃	OH	OCH ₃	Ar-H	O=C-NH
HL	2.37	1.18	11.52	3.83	7.26	7.76
M ₁ L	2.26	1.66	-	3.63	7.26	-
M ₂ L	2.29	1.65	-	3.60	7.26	-

Table 4: Conductance data for M₁L and M₂L complexes: Cell constant: 1.00

Metal complex	Conductance Ohm ⁻¹	Specific Conductance Ohm ⁻¹ cm ⁻¹	Molar Conductance Ohm ⁻¹ cm ² mol ⁻¹
M ₁ L	0.0054 × 10 ⁻³	0.0054 × 10 ⁻³	5.40
M ₂ L	0.0047 × 10 ⁻³	0.0047 × 10 ⁻³	4.70

Table 5: Electronic spectral data

Complexes	λ_{max} of the complex in nm	λ_{max} of the ligand in nm
M ₁ L	289.2	283



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M ₂ L	285.5	283
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Table 6 : Spin Hamiltonian and orbital reduction parameters of M₁L and M₂L complexes in DMF solution

Parameters	g_{\parallel}	g_{\perp}	g_{ave}	G	A_{\parallel}^*	A_{\perp}^*	A_{ave}^*	d-d	K_{\parallel}	K_{\perp}	P^*	α_2
M ₁ L	2.20464	2.0999	2.1348	2.0476	0.019	0.001	0.0069	16000	0.889	0.982	0.032	0.421
M ₂ L	2.24734	2.0699	2.1290	3.5369	0.011	0.001	0.0072	24600	0.724	0.845	0.029	0.414

Table 7: Magnetic moments of M₁L and M₂L complexes.

Metal Complexes	Effect in B.M.		Number of unpaired electron
	Theoretical	Observed	
M ₁ L	1.73	1.76	1
M ₂ L	5.92	5.44	5

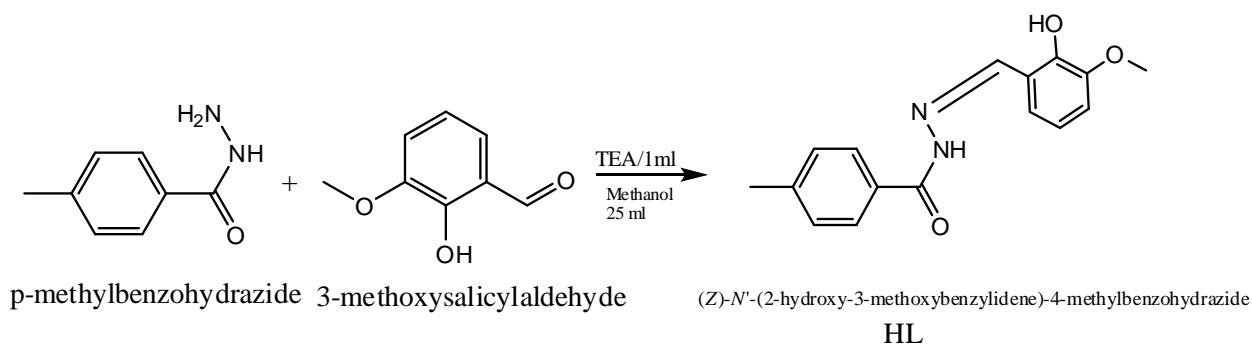
Table 8: Thermal analytical data of the HL ligand and its M₁L, M₂L metal complexes

Complex	Molecular weight in gms	Weight of the complex take in mgs	Temperature Range during weight loss in °C	%of fraction of weight	Probable assignment
M ₁ L	665.54	13.8020	80-190 280-810 Above 810	5.4091 82.6396 11.95119	Loss of 2H ₂ O molecule. Loss of two L molecules. Remaining residue Corresponds to CuO.
M ₂ L	656.938	9.0200	90-180 310-520 Above 520	5.4799 83.7217 10.7982	Loss of 2H ₂ O molecule. Loss of two L molecules. Remaining residue Corresponds to MnO.

Table 9: Antibacterial Activity of the Metal complexes Total Area of Zone of clearance in mm

Compound	<i>S. Typhi</i>	<i>E. Faecails</i>	<i>E. coli</i>
HL	12	14	15
M ₁ L	18	19	20
M ₂ L	16	18	20



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Scheme 1: Synthesis of Schiff base HL.

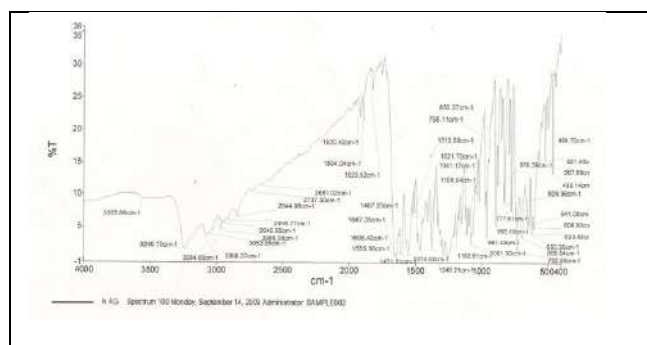


Figure 1: FT-IR Spectrum of HL Ligand

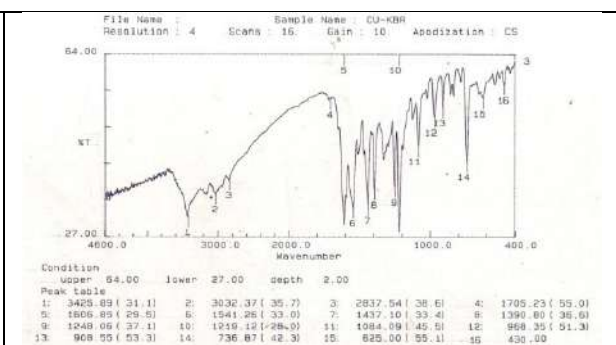


Figure 2: FT-IR Spectrum of M:L complex

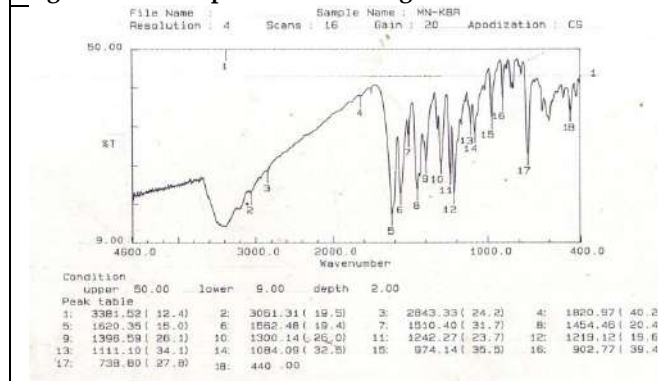
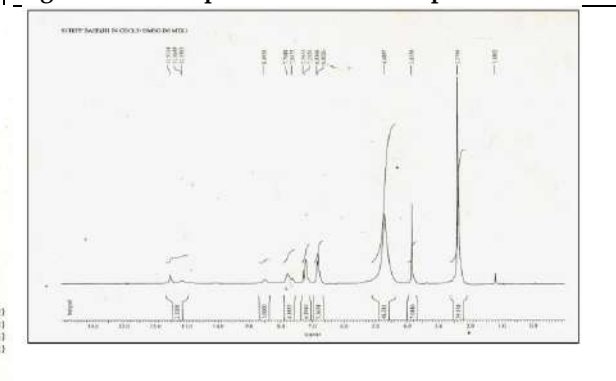
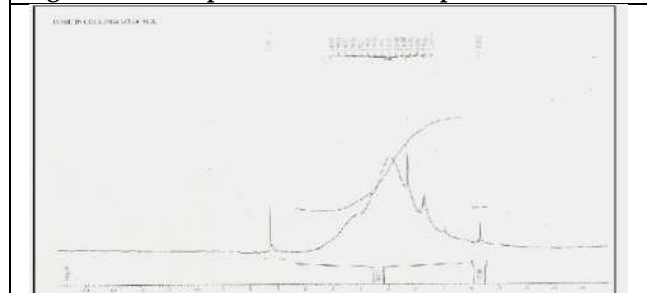
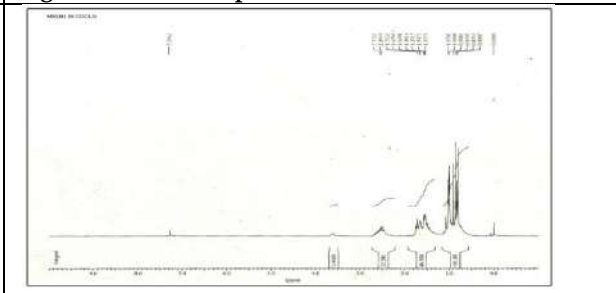
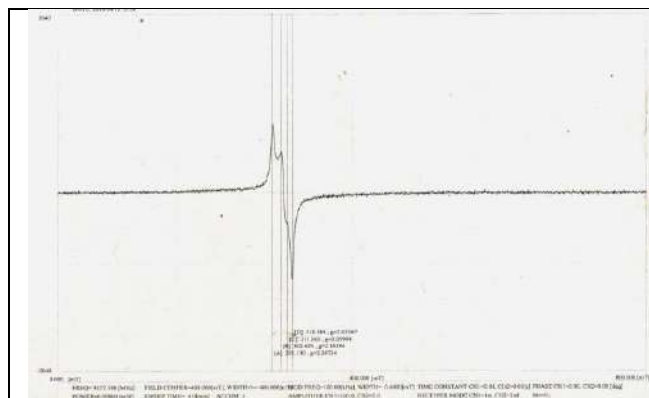
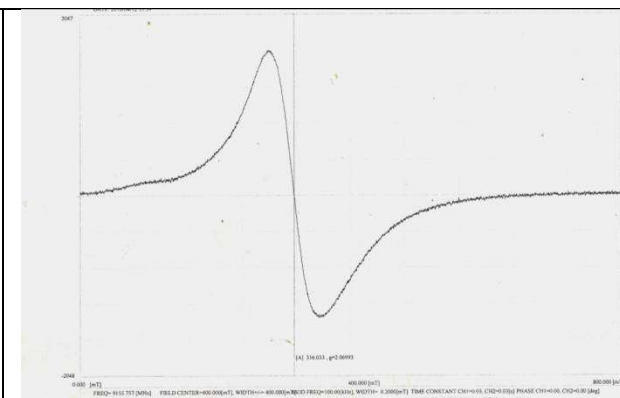
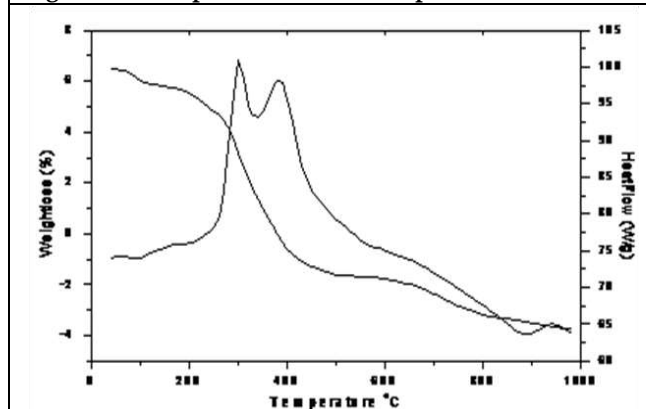
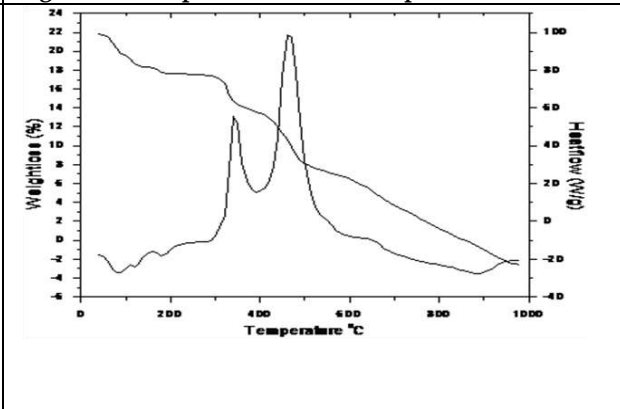


Figure 3: FT-IR spectrum of M:L Complex.

Figure 4: ¹H NMR Spectrum of HLFigure 5: ¹H NMR Spectrum of M:L complexFigure 6: ¹H NMR Spectrum of M₂L complex

Nageswara Reddy Gosu *et al.*,Figure 7: ESR Spectrum of M₁L complexFigure 8: ESR spectrum of M₂L complexFigure 9: TG & DTA Spectrum of M₁L complex.Figure 10: TG & DTA spectrum of M₂L complex



RESEARCH ARTICLE

Comparable Effects of Isolated and Combined Assisted and Resisted Sprint Training Programmes on Speed Endurance among College Women Athletes

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ABSTRACT

The purpose of the current study was to examine the effects of isolated and combination assisted and resisted sprint training programmes on speed endurance performance of college-aged female athletes. Sixty (N=60) female college athletes who were studying various colleges affiliated to Bharathidasan University in Tiruchirappalli, Tamil Nadu, India and participated inter collegiate athletic meet were chosen at random to serve as the study's subjects. The subjects were between the ages of 18 and 21. The participants were divided randomly into four groups of fifteen each, namely the Control Group, the Assisted Sprint Training Group, the Resisted Sprint Training Group, and the Combined Assisted and Resisted Sprint Training Group (CG). Assisted sprint training was used in Group I, resisted sprint training was used in Group II, combined assisted and resisted sprint training was used in Group III, and control training was used in Group IV. Three sessions per week were allowed during the training period, which was limited to twelve weeks for each of the three experimental groups. The training schedule for mixed assisted and resisted sprint training was limited to alternate weeks for a total of twelve weeks. Speed Endurance was chosen as the dependent variable, and it was assessed by 150 meters run test. The complete specified variable was examined on each individual both before and right after training. Analysis of covariance was used to statistically assess the data collected from the experimental groups prior to and following the experimental period (ANCOVA). The Scheffe's Post hoc test was used to ascertain the paired mean differences whenever the 'F' ratio for adjusted post test means was found to be

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significant. For each scenario, the degree of confidence was set at 0.05. The study's findings revealed that all three experimental groups—Assisted Sprint Training Group (ASTG), Resisted Sprint Training Group (RSTG), and Combined Assisted and Resisted Sprint Training Group (CARSTG)—had significant differences in Speed Endurance. Also, the study's findings demonstrated that combined assisted and resisted sprint training (ARSTG) improved Speed Endurance more than assisted sprint training (ASTG) and resisted sprint training (RSTG).

Keywords: Assisted Sprint Training, Resisted Sprint Training, Combined Assisted and Resisted Sprint Training, Speed Endurance

INTRODUCTION

The word sprinting is defined as the fast-paced movement of the legs and arms in rapid succession while maintaining control. There are many different aspects, as well as, many different distances in sprinting [1]. There is more to sprinting than just being the first one to the finish line. Over the course of the clinic, we will spend a great deal of time on the physical, mental, and biomechanical aspects of the sprinting world[2]. Sprints are high-intensity, short bursts of activity, performed at great speed and one of the most effective forms of training possible for building strength, speed and power whilst developing lean muscle mass and losing fat[3]. Primary Muscle. Sprint training is an excellent way to build muscle, burn fat and calories, and raise your metabolic rate, and it was the favored training method of sports legends such as Jerry Rice and Walter Payton[4]. Assisted and resisted training are specific types of facilitation and overload. They are concepts that are widely used in other types of training such as whole-body vibration (facilitation) and weight lifting (overload) [5]. Speed of movement can best be attained by practicing speed with lighter weight, whereas improved strength can best be attained with a maximum overloading of a muscle[6].

METHODOLOGY

Subjects and Variables

For this study sixty (N=60) college female athletes who were studying various affiliated colleges to Bharathidasan University, Tiruchirappalli, Tamil Nadu India were selected randomly as subjects. The age of the subjects was ranged between 18-21 years. The subjects were assigned at random into four groups of fifteen each (n=15) namely, Assisted Sprint Training Group (ASTG), Resisted Sprint Training Group (RSTG), Combined Assisted and Resisted Sprint Training Group (CARSTG), and Control Group (CG). Group-I underwent Assisted Sprint Training, Group-II underwent Resisted Sprint Training, Group-III underwent Combined Assisted and Resisted Sprint Training and Group-IV acted as Control. Speed Endurance was chosen as the dependent variable, and it was assessed by 150 meters run test

Training Protocol

The training programmes were scheduled for one session a day each session lasted between one hour approximately including warming up and warming down. During the training period, the experimental groups underwent their respective training programme three days per week (alternative days) for twelve weeks in addition to their college curriculum. The group-I concentrated on assisted sprint training, group-II on resisted sprint training, group-III on combined assisted and resisted sprint training. The assisted sprint training exercises included in this training programme was downhill sprinting, assisted towing and high-speed treadmill sprinting. The resisted sprint training exercises included in this training programme was weighted vest, sprint parachutes and harness running. The combined sprint training group performed the assisted and resisted sprint training methods. The training distance



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comprised of 30-50 meter and the initial intensity was fixed at 60% and it was increased once in two weeks by 5%. The subjects performed these training at maximum relaxed speed with the specified intensity. The rest intervals between repetitions were 2 minutes, where they stay with active and between sets, they performed other balance or trunk activities for 5 minutes. All the three groups had the same volume, intensity and frequency of training.

Experimental Design and Statistical Technique

The experimental design in this study was random group design involving 60 subjects, who were divided at random in to four group of fifteen each. The collected data from the four groups prior to and post experimentation on speed endurance was statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Since four groups were involved, whenever the obtained 'F' ratio value was found to be significant for adjusted post test means, the Scheffe's test was applied as post hoc test to determine the paired mean differences, if any.

RESULTS

The Analysis of covariance (ANCOVA) on Speed Endurance of Experimental Groups and Control group have been analyzed and presented in Table -1. Table-I shows that the pretest means and standard deviation on speed endurance of ASTG, RSTG, CARSTG and CG are 27.93 ± 2.86 , 28.67 ± 2.49 , 28.20 ± 4.28 and 28.07 ± 4.07 in that order. The attained 'F' ratio assessment of 0.12 was not as much of the essential table score of 2.76 for the quantity of freedom 3 and 56 at 0.05 level of assurance, which shows that the casual mission of the subjects was a success because the pre check scores on speed endurance among groups didn't vary drastically. The post-test means and standard deviation on speed endurance of ASTG, RSTG, CARSTG and CG are 36.40 ± 2.49 , 28.07 ± 2.82 , 40.93 ± 3.00 and 28.47 ± 4.37 respectively. The attained 'F' ratio assessment of 29.81 on speed was as much of the essential table score of 2.76 for the quantity of freedom 3 and 56 at 0.05 level of assurance. It implies that momentous variation existed between the groups during the post test phase on speed endurance. The adjusted post-test means on speed endurance of ASTG, RSTG, CARSTG and CG are 36.57, 37.80, 40.94 and 28.55 respectively. The attained 'F' ratio assessment is 41.58 of speed was as much of the essential table score of 2.78 for the quantity of freedom 3 and 55 at 0.05 level of assurance. The outcome of the study tells that, major differences be present among experimental and control groups on speed endurance. To determine which of the paired means had a significant difference, Scheffe's test was applied as Post hoc test and the results are presented in Table-2. The table-2 shows the pair wise comparison on speed endurance of different groups.

1. The results indicated that there were significant differences ($CI=3.33$) were found in ASTG and CARSTG(4.38), ASTG and CG (8.01), RSTG and CG(9.25)&CARSTG and CG(12.39).
2. The results indicated that there was no significant differences ($CI=3.33$) ASTG and RSTG (1.24),& RSTG and CARSTG (3.14).

The graphical representation of pre and post assessment means values are represented in the Fig.1. The graphical representation of adjusted post assessment means values are represented in the Fig.2.

CONCLUSIONS

From the analysis of the data, the following conclusions were drawn. Significant differences in achievement were found between AST group, RST group, CARST group and CG in Speed Endurance. The experimental groups namely, AST group, RST group, and CARST group had significantly improved in Speed Endurance. The CARST group was found to be better than the AST group, RST group and Control group in increasing Speed Endurance.





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Table – 1: Analysis of Covariance for Experimental Groups and Control Group on Speed Endurance

Certain Variables	Adjusted Post test Means				Source of Variance	Sum of Squares	df	Mean Squares	'F' Ratio
	ASTG	RSTG	CARSTG	CG					
Pre-Test Mean	27.93	28.67	28.20	28.07	Between	4.58	3	1.53	0.12
SD	2.86	2.49	4.28	4.07	With in	739.60	56	13.21	
Post Test Mean	36.40	28.07	40.93	28.47	Between	1282.73	3	427.58	29.81*
SD	2.49	2.82	3.00	4.37	With in	803.20	56	14.34	
Adjusted Post Test	36.57	37.80	40.94	28.55	Between	1250.80	3	416.93	41.58*
					With in	551.49	55	10.03	

* Significant at.05 level of confidence

Table value for df (3, 56) at 0.05 level = 2.76 Table value for df (3, 55) at 0.05 level = 2.78

(ASTG =Assisted Sprint Training Group, RSTG = Resisted Sprint Training Group, CARSTG= Combined Assisted and Resisted sprint Training Group, CG- Control Group)

Table – 2: The Scheffe's test for the differences between the adjusted posttests paired means on Speed Endurance

Certain Variables	Adjusted Post test Means				Mean Difference	Confidence Interval
	ASTG	RSTG	CARSTG	CG		
	36.57	37.80			1.24	3.33





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Speed Endurance	36.57		40.94		4.38*	3.33
	36.57			28.55	8.01*	3.33
		37.80	40.94		3.14	3.33
		37.80		28.55	9.25*	3.33
			40.94	28.55	12.39*	3.33

* Significant at .05 level of confidence

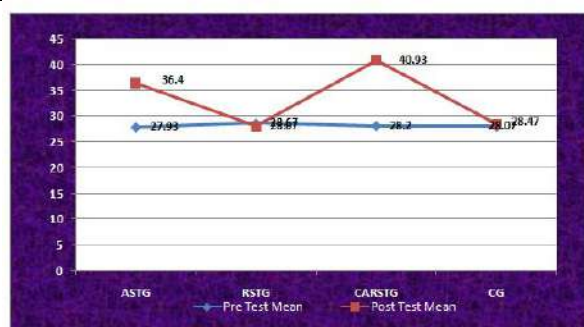


Fig-1: Pre and Post Test Means Diagram on Speed Endurance

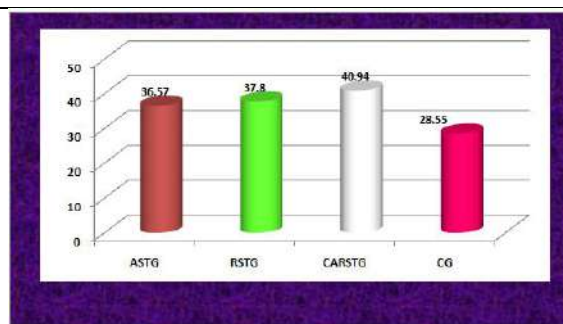


Fig-2: Adjusted Post Test Means Diagram on Speed Endurance





Comparative Phytochemical Screening and Antioxidant Mechanism of Methanolic Rhizome Extract of *Zingiber officinale* and *Curcuma amada*

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ABSTRACT

The present study was carried out the phytochemical screening and antioxidant analysis of *Zingiber officinale* and *Curcuma amada* were assessed. Various secondary metabolites was found from the methanolic rhizome extract of these two plants i.e alkaloids, flavonoids, saponins, phenols, tannins, glycosides, terpenoids, steroids, quinines, carbohydrate, protein and amino acids. Quantitative analysis of methanolic crude extract shows the presence of highest amount of flavonoid, phenolics and tannin in *Zingiber officinale* whereas in *Curcuma amada* the presence of tannin and saponin were highest in compare with other phytochemicals. Antioxidant activity was performed using DPPH assay, Nitric Oxide Scavenging activity and Superoxide scavenging activity with various extract concentrations (20, 40, 60, 80 and 100 µg /ml). It shows that methanolic rhizome extract of *Zingiber officinale* and *Curcuma amada* shows highest activity in DPPH scavenging assay (78.33 ± 0.39 & 69.15 ± 0.29) and Nitric Oxide Scavenging activity (NO) and Superoxide scavenging activity (SO) shows less capacity than DPPH (45.38 ± 0.2 & 37.59 ± 0.29 respectively) in *Zingiber officinale*. Where in *Curcuma amada* was found that Superoxide scavenging activity shows more activity than Nitric Oxide Scavenging activity (35.53 ± 0.35 & 48.52 ± 0.51 respectively).

Keywords: Phytochemical screening, *Zingiber officinale*, *Curcuma amada*, antioxidant, DPPH





INTRODUCTION

Perennial ginger (*Zingiber officinale*), which is frequently used in herbal medicine, grows from an underground rhizome. Modern scientific study has found that ginger has several positive health effects, including its antioxidant properties, ability to stop the manufacture of inflammatory chemicals, and direct anti-inflammatory actions. One of the most well-known spices in the world, ginger rhizome has been used for its therapeutic properties in complementary medicine for more than 2,500 years [1]. China, Nepal, India, Bangladesh, the United States, Taiwan, Jamaica, Nigeria, and Indonesia are among the countries where it is grown. It has been used to treat a wide range of illnesses like throat infections, asthma, inflammation, palpitations, constipation, indigestion, arthritis, hypertension, migraines, and many more in Ayurvedic, Tibb-Unani, Chinese, Islamic, Africans, and other medicinal systems [2]. Ginger's a food spice, which the American Diabetic Association has also endorsed as a dietary supplement. Nutraceutical food is a dietary product that provides necessary health benefits such as prevention of disease and treatment [3]. A perennial, rhizomatous, aromatic herb in the Zingiberaceae family, *Curcuma amada* Roxb. Due to the flavour of the rhizome resembling raw mango, this plant is also known as "Amahaldi," "Amba ada," and "Mango ginger" [4,5]. It was first found in the Indo-Malayan region and afterwards spread over Asia's tropics to Africa and Australia. Aromatic herbs and therapeutic plants are utilised as food additives.

For a very long time, pharmaceutical businesses have used unprocessed plant extracts to create treatments for corrective medicine [6]. Research on medicinal plants has a bright future in both academia and industry [7]. More natural resources are used by the pharmaceutical sector to produce more than half of all new medications [8]. Many medicinal plants can prevent a variety of diseases from developing in the first place, and conventional therapies and approaches have recently demonstrated that diseases can be controlled [9]. The therapeutic properties of plants and herbs are influenced by the presence of bioactive constituents like flavonoids, alkaloids, saponins, glycosides, tannins, steroids, terpenoids, and phenolic compounds, among others [10]. Humans are affected in a certain physiological way by this. As a result of the adverse consequences brought on by the synthetic molecular medications employed in allopathic treatment, individuals eventually began to accept herbal or traditional treatments [11]. Aside from humans, herbal medicinal plants can treat the illnesses of the rest of the world's living things. According to [12], fresh ginger was used in ancient India and China to treat asthma, heart palpitations, swelling, loss of appetite, coughing, rheumatism, fever, diarrhoea and sore throats. It has been used for millennia to aid in digestion, avoid motion sickness and seasickness, inhibit vomiting, and ease other symptoms of the common cold, fever, headache, and even painful menstrual periods. It is also thought to increase circulation and enhance blood flow [13]. The therapeutic qualities of ZO have been thoroughly researched in recent decades using cutting-edge scientific techniques, and numerous bioactive substances have been extracted from various plant components [14]. According to [13], it contains significant amounts of Zingiberene, sesquiphellandrene, geranial, and ar-curcumene. Its extracts and active compound exhibited antimicrobial, anticonvulsant, analgesic, anti-inflammatory, antiulcer, gastric antisecretory, antidiabetic, nephroprotective, hepatoprotective, antitumor, anticancer, antispasmodic, antithrombotic, hypocholesterolemic, antiallergic, antiserotonergic, anticholinergic, antioxidant, larvicidal, immunomodulatory activities and other beneficial activities [14].

Also regarded as possible cancer-prevention and anticancer medicines are gingerol and its derivatives. Less than 10% of medical drugs are currently used in Western countries for the prevention and treatment of gastrointestinal problems. This represents a 50% usage rate. According to [15], the threat of intestinal disorders, the low cost, and the accessibility of herbal remedies were the main factors driving this rise in the use of medicinal plants. One of the most popular spices in the world is ginger, and extracts from it are suggested in many nations' pharmacopoeias for a number of gastrointestinal illnesses, as explained below by [16]. More than forty natural substances, including paradols, dihydroparadols, gingerols, shogaols, 3-dihydrosogaols, gingerdiols, mono and diacetyl derivatives of gingerdiols, and diarylheptanoids, have been isolated from ginger. Numerous pharmacological properties of ginger have been identified, including anti-bacterial [17], antioxidant [18], antiviral [19], antiulcer [15], hypoglycemic, and hypolipidemic effects [20], as well as benefits for nausea relief [21]. In the GIT, ginger has additionally demonstrated



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anticancer properties [22]. Scientific research on the purported therapeutic effects and careful examination for potential toxicity are now necessary due to the rise in the intake of plant extracts intended to treat gastrointestinal diseases. There aren't many research showing ginger's effectiveness as a gastroprotective agent, as observed by [21]. Mango-ginger, also known as *Curcuma amada* Roxb, is a main component in pickles, sauces, chutneys, and salads and has a peculiar aroma reminiscent of raw mangoes. A pitta imbalance, indigestion, flatulence, gout, skin conditions, cramps, damaged wounds, chronic ulcers, pruritus, fever, constipation, hiccup, anorexia, bronchitis, sprains, halitosis, and inflammations can all be treated with this plant's rhizomes [23,24]. According to [4], this plant is grown in several Indian states, including Odisha, however commercial multiplication has not yet been documented. Since ancient times, *C. amada* has been used in Ayurveda and Unani traditional medical systems as a coolant, appetiser, alexteric, antipyretic, aphrodisiac, diuretic, emollient, expectorant, and laxative as well as to treat biliousness, itching, skin conditions, bronchitis, asthma, hiccups, and inflammation caused by injuries [23]. This plant's rhizome, along with table salt, is used to treat colds and coughs as well as to improve the quality of blood. According to [25], its rhizome has also been utilised for the treatment of cuts, wounds, and itching.

MATERIALS METHODS

The disease-free and fresh rhizome of *Z. officinales* and *C. amada* plant sample was collected from local market. The collected plant rhizome was rinsed with clean tap water to remove the debris, dust, and soil from the surface. The cleaned rhizome was scissored and shadow-dried and pulverized by an electric pulverizer. The Soxhlet apparatus-based extraction method was followed to extract the phytochemicals present in the rhizome of *Z. officinales* and *C. amada* by following standard methodology. In brief, about 100g of rhizome sample was extracted with 500ml of methanol with the help of soxhlet apparatus. Then, methanol extract was evaporated, and obtained fine extract was completely and gradually in the oven and subjected to phytochemical properties analyses.

Qualitative analyses of phytochemicals

The phytochemical profiles (Qualitative analysis: alkaloids, flavonoids, saponins, phenols, tannins, glycosides, terpenoids, steroids, quinones, carbohydrates, proteins and amino acids [26])

Quantitative phytochemical analysis

Rhizome powder sample was used for quantitative phytochemical analysis in terms of tannin, saponin, phenolic, and flavonoid as described by [27] and alkaloid content was estimated using the procedure described by [28]. The content of saponin, alkaloid, and flavonoid was expressed as mg/g in dry weight of rhizome sample. Quantitative analysis for phenolics and tannins was carried out based on gallic acid (GAE) and tannic acid (TAE), the standard curve was prepared and the data were presented in mg standard equivalent weight/g of the dry weight of rhizome and leaf sample of *Z. officinale* and *C. amada*.

Antioxidant activity

Diphenyl 1 picryl hydrazyl free radical scavenging activity

This scavenging effect on the DPPH radical was determined according to the methods developed earlier [29, 30]. Different extract concentrations (20, 40, 60, 80, and 100 µg /ml) were combined with 5 ml of a 0.004% DPPH methanolic solution. Each mixture was left in the dark for 30 minutes while a UV spectrophotometer measured the samples' absorbance at 517 nm. Daily preparations of fresh DPPH solution were made, and between measurements, they were kept at 4°C in the dark in an amber light bottle. The control and standard underwent the identical method, with the exception that the control did not have any sample added to it, and the standards had 20, 40, 60, 80, and 100 µg of sample substituted with 20, 40, 60, 80, and 100 µg /ml of BHT, catechin, and gallic acid instead. A lower absorbance indicates higher radical scavenging power. DPPH radical scavenging activity was calculated by following equation.

$$\text{DPPH Radical scavenged (\%)} = \left[1 - \frac{A_t}{A_o} \times 100 \right]$$





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where A_t is the absorbance of the sample and A_o is the absorbance of the control at 517 nm.

Nitric oxide radical scavenging activity

Nitric oxide (NO) was generated from sodium nitroprusside (SNP) and was measured by the Griess reagent. The idea behind it is that SNP in aqueous solution at physiological pH naturally produces NO, which reacts with oxygen to form nitrite ions, the amount of which can be calculated using the Griess Reagent. As NO scavengers compete with oxygen, NO generation is reduced. Different amounts of extract (20, 40, 60, 80, and 100 µg/ml) dissolved in acetone were combined with two millilitres of SNP (10 mM) in phosphate buffer saline (PBS) at a pH of 7.4. The mixture was then incubated at 25°C for two and a half hours. The Griess reagent (1% sulphanilamide, 0.1% naphthylethylenediamine dichloride, and 2 ml orthophosphoric acid) was added to the samples from the previous steps. Pink will start to emerge. Absorbance was read at 546 nm. Ascorbic acid was taken as standard [31]. Nitric oxide scavenging activity was calculated by following equation.

$$\text{Nitric Oxide scavenged (\%)} = \left[1 - \frac{A_t}{A_o} \times 100 \right]$$

where A_t is the absorbance of the sample and A_o is the absorbance of the control at 546 nm.

Super oxide radical scavenging activity

1 ml of Nitroblueterazolium (156 Mm), 1 ml Nicotinamide adenine dinucleotide (reduced) (468 Mm) and 0.1 mL of Phenanzine methosulphate solution (PMS) in 0.1 M of phosphate buffer solution (pH 7.4) were added to 0.1 ml extract of different concentrations (20, 40, 60, 80 and 100 µg) and of 20, 40, 60, 80 and 100 µg then incubated at 25°C for 5 min and absorbance was read at 560 nm against blank containing all reagent except PMS. Ascorbic acid was taken as standard [32]. Super oxide radical scavenging activity was calculated by following equation.

$$\text{Superoxide Radical scavenged (\%)} = \left[1 - \frac{A_t}{A_o} \times 100 \right]$$

where A_t is the absorbance of the sample and A_o is the absorbance of the control at 560 nm.

RESULT AND DISCUSSION

Due to their safety and lack of adverse effects, herbal medications are frequently utilised in developing and even industrialised nations. They are also widely used, especially in many Asian and African nations [33]. One of the nations that heavily relies on herbal medicine to suit its healthcare demands is India. In this country, the market for herbal pharmaceuticals is estimated to be worth \$1 billion and the export of plant-based crude drugs is estimated to be worth \$80 million. India, unlike China, has not been able to encourage the use of its enormous herbal resources throughout the developed world despite their growing interest in herbal therapy [34].

Qualitative analysis

Methanolic extract of *Z. officinales* rhizomes contains alkaloid, flavonoids, steroids, phenols, glycosides, terpenoids, quinines, carbohydrates, protein and amino acids with exception for saponins were in Table-1. According to [35] stated that the methanolic extract of *Z. officinale* contains atleast all the phytochemicals except saponin. [36] explained the presence of alkaloid, saponins, tannins, flavonoids, terpenoids and phlobatannins and absence of steroids. Methanolic extract of *C. amada* rhizome contains alkaloids, flavonoids, saponins, phenols, tannins, glycosides, terpenoids, steroids, quinones, carbohydrate, proteins & amino acids. According to phytochemical analysis of [37] describes the presence of alkaloids, flavonoids, saponins, tannins, carbohydrates, protein and fibre in the rhizome extract of mango ginger. [38] also stated the presence of phenols, flavonoids, tannins and saponins in the aqueous methanolic extract of *C. amada*. [39] also observed the presence of different phytochemicals like tannin, saponins, flavonoids, alkaloids and phenolics were present in water, acetone, methanol, ethanol and chloroform solvent.



Debasish Dikshit *et al.*,**Quantitative analysis**

Quantitative analysis of *Z. officinales* found the presence 35.12 ± 1.05 mg/g DW alkaloid, 95.56 ± 2.87 mg/g DW of flavonoid, 86.25 ± 2.59 mg GAE/g DW of phenol, 62.12 ± 1.86 mg TAE/g DW of tannin, 28.11 ± 0.84 % of carbohydrate and 33.16 ± 0.99 % of protein were shown Table-2. In *Z. officinales* the presence of more phenolic and flavonoid contains was observed by [40]. Quantitative analysis of methanolic rhizome extract of *C. amada* was estimated and found the presence of 17.17 ± 0.52 mg/g DW alkaloid, 14.91 ± 0.45 mg/g DW of flavonoid, 25.12 ± 0.75 mg/g DW of saponin, 9.51 ± 0.29 mg GAE/g DW of phenol, 91.56 ± 2.75 mg TAE/g DW of tannin, 16.59 ± 0.5 % of carbohydrate and 6.19 ± 0.19 % of protein were shown in Table-2. [41] observed the presence of highest amount total flavonoid in methanolic extract than other extracts. [39] showed the presence of tannin which known for anti-oxidant activity and the presence of flavonoid useful in development of living organism.

Antioxidant activity

The DPPH Assay was showed that the highest percentage of RSA increases while increasing in the concentration of extract upto $100 \mu\text{g/ml}$ (78.33 ± 0.39), while the highest IC₅₀ value was recorded $144.1 \mu\text{g/ml}$ and gradually decrease in the antioxidant capacity was observed in Nitric oxide radical scavenging assay where concentration of extract in $100 \mu\text{g/ml}$ (45.38 ± 0.2) and IC₅₀ value was $287.16 \mu\text{g/ml}$ in methanolic extract of rhizome of *Zingiber officinale*. In Superoxide radical scavenging assay shows least amount of antioxidant capacity in $100 \mu\text{g/ml}$ (37.59 ± 0.29) where IC₅₀ value was $351.58 \mu\text{g/ml}$ in methanolic extract of rhizome of *Zingiber officinale* were shown in Fig-1. Like this trend also observed in *C. amada* where highest amount of antioxidant capacity was observed in DPPH assay in concentration upto $100 \mu\text{g/ml}$ (69.15 ± 0.29) where IC₅₀ value was $166.9 \mu\text{g/ml}$. Gradually decreased in Superoxide radical scavenging assay in $100 \mu\text{g/ml}$ (35.53 ± 0.35) and IC₅₀ value was $296.62 \mu\text{g/ml}$ observed as compare to DPPH. In Nitric oxide radical scavenging assay observed the least amount of antioxidant capacity in $100 \mu\text{g/ml}$ (48.52 ± 0.51) where IC₅₀ value was $246.97 \mu\text{g/ml}$ observed and were shown in Fig-2. According to [42], solvent extraction outperformed water extraction in terms of antioxidant activity using three different methodologies.

Following is the order of free radical scavenging activity by DPPH and antioxidant activity by reducing power. 80 percent methanol > 80 percent ethanol > 80 percent methanol > 30 degree water > 100 degree water > acetonic extract. According to Z. Mushtaq *et al.*, 2019 The inhibition of ethanolic extracts (66.04%) and methanolic extracts (55.57% and 53.29%) of hybrid ginger was less than that of ginger powder. In [43] stated "The extract showed significant activities in Superoxide anion scavenging activity assay, Hydroxyl radical scavenging activity assay, Nitric oxide scavenging activity assay, DPPH free radical scavenging assay, and hydrogen peroxide antioxidant assays compared to the standard antioxidant in a dose dependent manner and remarkable activities to scavenge reactive oxygen species (ROS) may be attributed to the high amount of hydrophilic phenolics. The IC₅₀ values of all parameters were determined while ascorbic acid was used as standard. Conclusion: The results obtained in the present study indicate that *Z. officinale* extract is a potential source of natural antioxidant." Plants that have an antioxidant function in the production of new medicinal products are useful to the pharmaceutical industries, [44]. Various free radicals, including the hydroxyl radical, have been linked to a number of disorders, including atherosclerosis, carcinogenesis, and neurological and cardiovascular diseases [45]. Antioxidant molecules work to lower these free radicals [45]. The research of [46] indicates that there was an increased level of antioxidant activity from methanol extracts. These findings correspond to those of [47] who investigated the antioxidant activity of a ginger alcohol extract from Vietnam and found that radical inhibition by DPPH was up to 90.1%. The aqueous extracts of ginger were discovered to have strong antioxidant properties by [48] in Finland, where the IC₅₀ value for the suppression of DPPH radical was 9 mg/mL. The DPPH radical was more inhibited by the cumin methanol extract than by the ginger and hexane extracts, but less so than by the ginger extracts.





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Table 1: Different tests performed for the qualitative phytochemical analysis of methanolic rhizome extract of *Zingiber officinale* and *Curcuma amada*.

Qualitative analysis of methanolic rhizome extract of <i>Z. officinale</i> and <i>C. amada</i>			
Phytochemicals		<i>Z. officinale</i>	<i>C. amada</i>
Alkaloids	Mayer's test	+	+
	Wagner's test	+	+
	Hager's test	+	+
Flavoids	Shinoda test	+	+
	Alkaline reagent test	+	+
	Ferric chloride test	+	+
Saponins	Foam test	-	+
	olive oil test	-	-
Phenols	Ferric chloride test	+	+
	Lead acetate	+	+
Tanins	Bromine water test	+	+
	wohler's test	+	+
	Braymer's test	+	+
Glycosides	Liebermann's test	+	+
	Salkoowski's test	+	+
Terpenoids	Salkoowski's test	+	+
Steroids	Liebermann's test	-	-
	Salkoowski's test	+	+
Quinones	Sulphuric Acid test	+	+
Carbohydrates	Molich's test	+	+
	Burfoed's test	+	-
	Benedict's test	+	+



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Protein and amino acids	Millon's test	+	-
	Ninhydrin test	+	-
	Copper Sulphate test	+	+

Table 2: Shows the value of quantitative phytochemical analysis of methanolic rhizome extract of *Zingiber officinales* and *Curcuma amada*. Value in column shown mean with Standard deviation (\pm SD), % percentage, GAE gallic acid equivalent, TAE tannic acid equivalent.

Quantitative analysis of methanolic rhizome extract of <i>Z. officinale</i> and <i>C. amada</i>		
Phytochemicals	<i>Z. officinale</i>	<i>C. amada</i>
Alkaloid (mg/g DW)	35.12 \pm 1.05	17.17 \pm 0.52
Flavonid (mg/g DW)	95.56 \pm 2.87	14.91 \pm 0.45
Saponin (mg/g DW)	-	25.12 \pm 0.75
Phenolics (mg GAE/g DW)	86.25 \pm 2.59	9.51 \pm 0.29
Tannin (mg TAE/g DW)	62.12 \pm 1.86	91.56 \pm 2.75
Carbohydrate (%)	28.11 \pm 0.84	16.59 \pm 0.5
Protein(%)	33.16 \pm 0.99	6.19 \pm 0.19

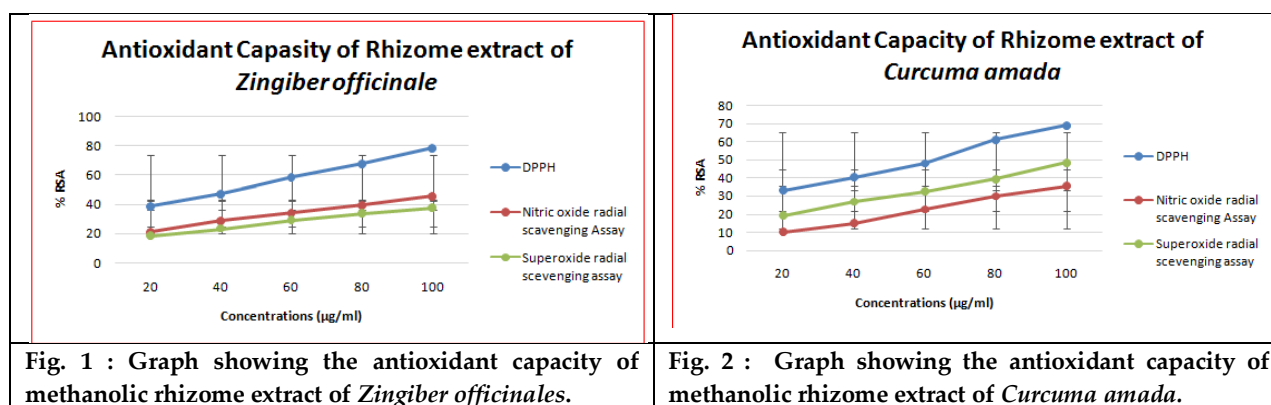


Fig. 1 : Graph showing the antioxidant capacity of methanolic rhizome extract of *Zingiber officinales*.

Fig. 2 : Graph showing the antioxidant capacity of methanolic rhizome extract of *Curcuma amada*.





Biocompatible Synthesis of CdSO₄ Doped Reduced Graphene Oxide(Cs-Rgo) Nanomaterials : Structural, Optical and Morphological Characterization

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ABSTRACT

Graphene oxide is a material that can be used to make capacitors, batteries, actuators, biosensors, and other devices because of its exceptional mechanical and electrical capabilities, thermal conductivity, specific surface area, and configurable band gap. Graphene oxide and reduced graphene oxide were created in this study using a green synthesis method. Due to the risky and explosive nature of hydrazine and its derivatives, a simple, inexpensive green synthesis method has been used in this work for the reduction of graphene oxide (GO). The graphene oxide that was employed in this work was initially created by oxidising graphite using a modified Hummer's process. The work investigates the use of fruit extract from *Citrus sinensis* L. to produce reduced graphene oxide (rGO) from graphene oxide in a sustainable and environmentally friendly manner. In the large-scale synthesis of rGO, the current study suggests that *Citrus sinensis* L. juice is a suitable replacement for potentially harmful reducing agents including sodium borohydride, hydrazine, and dimethyl hydrazine. To change the characteristics of the



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rGO nanomaterial, cadmium sulphate was doped into it. SEM, TEM and AFM were employed to assess the structural morphology and particle size of cadmium sulphate doped rGO (CS-rGO). The UV-visible absorption spectroscopy was used to assess the optical characteristics.

Keywords: graphene oxide; modified Hummers process; green synthesis; fruit extract; doping;

INTRODUCTION

The requirement for the sustainable expansion of green chemistry is increased by the growing environmental crisis being addressed by renovation [1,2]. Exploring materials with desirable qualities that are also derived from natural resources is therefore urgently needed [3,4]. Since many years ago, graphene and its derivatives have been employed as a successful material to address environmental issues. The newest member of the carbon family is graphene, which has a 2D layered structure and sp^2 hybridised conjugated carbon network. It is a single atom thick planar sheet that is filled with a honeycomb crystal lattice [5]. Because of its superior mechanical, electrical, thermal, and optical capabilities, graphene will be examined in various fields, including nanoelectronics, sensors, batteries, nanocomposites, supercapacitors, and hydrogen storage. Mechanical exfoliation [6], chemical vapour deposition [7], liquid-phase exfoliation [8], and chemical approach via reduction of graphene oxide (GO) [9] are efficient synthesis techniques for high-quality single-layer graphene. The most widely used technique for using reducing agents such as hydrazine [10], sodium borohydride [11] and hydroquinone [12] is chemical reduction. Therefore, the reductants are extremely poisonous and bad for the environment. By using a reduction technique to raise the cost, irreversible aggregation of graphene oxide (GO) in a soluble solution, hazardous waste of chemical agents is produced. Chemical techniques are used in all these graphene issues to restrict use. In order to overcome these difficulties, plants are being subjected to novel techniques like the biological reduction method and green synthesis method, and fruit juice or pathogens serve as environmental reducing agents [13]. Poonam Rani *et al.* have synthesised rGO from GO as a precursor and peel extract of lemon as a reducing agent by green chemistry approach [14]. Prema Thanapackiam *et al.* reported on comparative studies of graphene oxide and reduced graphene oxide nanomaterials. [15]. Doping reduced graphene oxide makes it into a semiconductor with a tuneable bandgap [16]. Cadmium sulphate doped reduced graphene oxide, also known as CS- rGO, could help to partially restore conductivity. The CS-rGO exhibits good electron conductivity and behaves like a semiconductor. It was the first time that cadmium sulphate was utilised as a dopant in this experiment. In this study, the impact of cadmium sulphate is examined with respect to the structural, electrical, morphological studies of rGO nanomaterial.

EXPERIMENTAL METHODS

Materials

The chemicals used were all of analytical quality and did not require further purification. They included graphite (99% acid treated), sodium nitrate (98%), potassium permanganate (99%), hydrogen peroxide (40% wt.), sulphuric acid (98%), hydrochloric acid (35%), and cadmium sulphate. Double-distilled water was utilised throughout the experiment.

Synthesis of graphene oxide

In this procedure, 4 g of powdered graphite, 8 g of P_2O_5 , and 12 ml of H_2SO_4 were combined and agitated for 6 hours. Then, 12 ml H_2SO_4 and 8 g $K_2S_2O_8$ were added, and stirring was carried out for an additional 6 hours. It was then allowed to cool before being diluted with 300 ml of double-distilled water. This mixture was filtered using a Whatman 41 filter before being dried in a hot air oven for two hours at 60 °C. Then, while stirring continuously for two hours, 2 g of this peroxidized graphite powder was gradually added to a combination of 92 ml H_2SO_4 and 12 g $KMnO_4$ together with 2 g of $NaNO_3$. Fig.1 shows the steps of preparation and prepared graphene oxide nanopowder. This liquid was diluted, and then 10 ml of 30% H_2O_2 was added drop wise. After a few minutes, 500 ml of distilled



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water was added along with this solution. While it was being filtered, it was rinsed with diluted HCl. The resulting brown suspension was then heated to 60 °C in a hot air oven before being sonicated for 10 minutes with a few drops of H₂O₂. The exfoliated GO nanoparticles are the acquired resulting solid. In order to store it for future experiments and characterizations, it was further dried in a hot air oven. In order to prepare a large amount of GO, the entire process was repeated. [17].

Synthesis of cadmium sulphate doped reduced graphene oxide (CS-rGO)

Reducing graphene oxide from graphene oxide particles has been achieved by an eco-friendly and simple experimental approach that makes use of efficient bio-extracts. In this experiment, extract from *Citrus sinensis* L., commonly referred to as orange fruit, was used. I purchased it from a local store, and I used a sanitised plastic container to squeeze out the juice. Then, to dilute it, 100 millilitres of double-distilled water was added. One mole of cadmium sulphate and one hundred milligrammes of graphene oxide were then added to the extract solution exactly. The Ultra Probe Sonicator, Model: SM150W, was used to sonicate the mixture for around thirty minutes. A black liquid was being smeared everywhere. Subsequently, the mixture was placed in an IFB 20SC2 20 L Convection Microwave Oven and centrifuged for 30 minutes at 4000 rpm, then for 10 minutes at 800 W. Consequently, rGO-doped cadmium sulphate nanomaterial (CS-rGO) was produced. The synthesised CS-rGO nanomaterial is shown in figure

Instrumentation

Using a PhilipsXL-20 electron microscope equipped with an energy dispersive X-ray analyser (EDAX), the sample's surface morphology was determined. The Nanosurf easy2 scan BT02218 profilometer was used to conduct the atomic force microscopy (AFM) examination. A Nicolet6700 FTIR spectrometer was used to analyse the synthesised sample in the 4000-400 cm⁻¹ band for the presence of functional groups. Using HRTEM: Jeol/JEM 2100, the sample's change in stacking properties and particle size were examined. A thin layer of amorphous carbon coating was applied to the sample before it was placed on a copper 200-mesh TEM grid and ready for examination. The Origin Lab 9.0 software was used to create all of the graphics.

RESULTS AND DISCUSSION**Functional groups of cadmium sulphate doped rGO**

FT-IR spectroscopic examination was performed using an FT-IR spectrometer, and the sample's recorded FTIR spectrum is shown in figure 3. A carboxylic acid group with O-H stretching vibrations is shown by the signal at 3136 cm⁻¹. Stretching vibrations of the C-C atom are visible in the peaks at 2921 and 2851 cm⁻¹. Alkene (C=C) group is associated with the peak at 1609 cm⁻¹. O-H bending mode is represented by the 1399 cm⁻¹ peaks. The dopant cadmium sulphate in rGO exhibits asymmetric stretching, symmetric stretching, asymmetric bending, and asymmetric bending, which are represented by the peaks at 1116, 1034, 618, and 460, respectively. The CdSO₄ doped rGO sample's numerous functional groups are listed in table 1 [18,19].

UV-visible spectral studies

Due to photo generated electron hole carriers in the particles, UV visible absorption spectroscopy is a valuable tool to monitor the size dependant optical characteristics of the nanomaterials. The absorbance spectra of rGO doped with CdSO₄ is seen in Figure 4. The cut-off wavelength is determined to be 282 nm from the graph. In the case of rGO, a sharp peak was seen at 273 nm, while in the case of rGO doped with CdSO₄, the cut-off wavelength is seen to be higher, indicating that the sample is more conductive. In the case of CdSO₄ doped rGO, the observation shows that the absorption is high and closely resembles the individual peaks of the material's components, indicating a strong coupling between the CdSO₄ doped with rGO (CS-rGO) sheets. For making nano porous heterojunction solar cells, this sample is hence helpful. From corresponding electronic changes inside the sample, absorption in the near UV range results. By applying the formula $E_g = 1240/\lambda$, where λ is the cut-off wavelength, optical band gap (E_g) was calculated. The result was 4.39 eV for cadmium sulphate doped rGO[15]. Due to the dopant's presence in the host





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reduced graphene oxide (rGO), CS-rGO nanomaterial has a lower band gap value than reduced graphene oxide. The values of the extinction coefficient (k), reflectance (R) and refractive index (n) of the sample have been determined by using the following relations [20,21].

$$k = \alpha\lambda/4\pi$$

$$n = \left(\frac{1}{T} + \left(\frac{1}{T} - 1 \right) \right)$$

$$R = (n - 1)^2 / (n + 1)^2$$

Figures 5, 6, and 7 show the graphs of these parameters, and, vs wavelength, respectively. The outcome shows that for CS-rGO nanomaterial, the extinction coefficient is of the order of 10^{-5} and rises as the wavelength increases. Refractive index value is seen to be rising up to 500 nm and remaining constant between 500 and 900 nm in wavelength. The sample's reflectance value is low in the UV area and steady in the visible-IR range.

SEM analysis

Using a scanning electron microscope (SEM), the surface morphological behaviour of CdSO_4 doped rGO was investigated. Figure 8 shows SEM micrographs of the sample at various magnifications. where it can be seen that there are several exfoliated layers that have been layered on top of one another to produce bulk sheets that are thick and opaque in appearance. The host CS-rGO nanomaterial's dopant cadmium sulphate material is indicated by the tiny white spots and different shapes. The sheets overlapping and merging aggregation appears to be reducing the surface area [22,23].

EDAX analysis

EDAX is an analytical method for examining the chemical make-up of several elements in a sample and figuring out how abundant they are in relation to one another. Figure 9 displays the CS-rGO nanomaterials EDAX spectrum as it was captured. The EDAX spectrum provides unequivocal confirmation of the presence of cadmium sulphate in the rGO sample. Sharp peaks in the spectrum confirm that components like Cd, O, S, and C are present. The values of the various elements' weight percentages and atomic percentages in the sample are shown in table 2. Thus, it is proven that the dopant CdSO_4 is present in the rGO nanomaterial as ions [24].

TEM images

HRTEM: Jeol/JEM 2100 was used to examine the hetero-structural morphology of the synthesised CdSO_4 doped rGO nanomaterial. Particle size and distribution morphology of the material can both be covered by TEM investigation. The sample's HRTEM images taken at various magnifications (10 nm, 20 nm, 50 nm, 100 nm, and 200 nm) are shown in figure 10. The findings show that the CS-rGO nanomaterial contains rGO sheets and layers as well as nanoparticles with sphere-like shapes. The thickness of the sheets is approximately 25 nm, while the nanoparticle size is less than 10 nm. CdSO_4 is beneficial for electronic charge transfer in rGO material [25,26].

AFM Study

An effective method, atomic force microscopy (AFM) allows for the imaging of nearly any surface, including polymers, ceramics, composites, glass, and biological samples. Adhesion strength, magnetic forces, and mechanical properties are just a few of the various forces that may be measured and localised using AFM. Figure 11 shows two-dimensional and three-dimensional topographical images of the CdSO_4 doped rGO nanomaterial show that the sample is made up of sheets and agglomerated granular-sized particles [27,28].





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CONCLUSION

In this work, green synthesis was used to create cadmium sulphate-doped reduced graphene oxide (CS-rGO) nanomaterial. The advantages of this activity include its low cost, avoidance of dangerous reducing chemicals, lack of hazardous waste, and excellent purity of the usable nanomaterial. The presence of all the anticipated functional groups is confirmed by the IR spectra. Utilising the UV-visible optical data, the linear optical characteristics of the CS-rGO nanomaterial, including absorbance, extinction coefficient, refractive index, and reflectance, were assessed. SEM, TEM and AFM examinations were used to analyse surfaces. The TEM pictures of the CS-rGO sample show that there are well-dispersed cadmium sulphate particles on the nanosheets.

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Table 1: FTIR data and functional group assignments for cadmium sulphate doped rGO nanomaterial

Wave number (cm ⁻¹)	Spectroscopic assignments
3136	O-H stretch
2921, 2851	C-C stretching
1609	Alkene (C=C)
1399	O-H bending
1116	Asymmetric stretching of sulphate ion
1034	Symmetric stretching of sulphate ion
618	Asymmetric bending sulphate ion
460	Symmetric bending of sulphate ion

Table 2: Values of wt% and atomic weight % of elements in CS-rGO nanomaterial

ELEMENT	LINE TYPE	WT%	ATOMIC WEIGHT%
C		52.10	61.68
O	K series	27.75	30.59
S	K series	7.58	4.17
Cd	L series	11.67	3.55

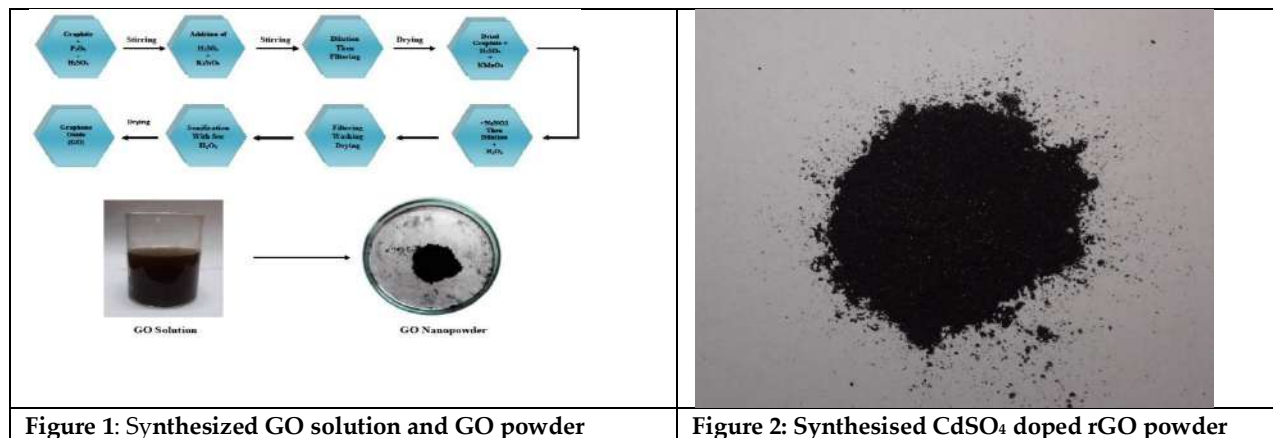


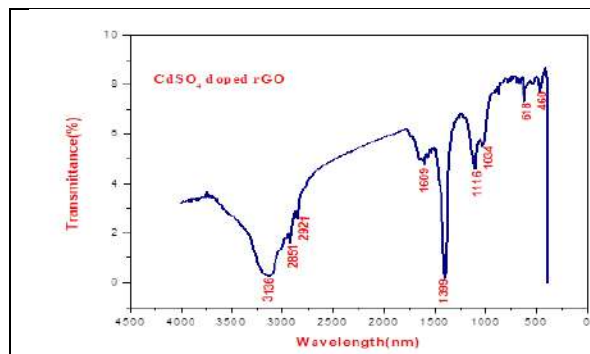
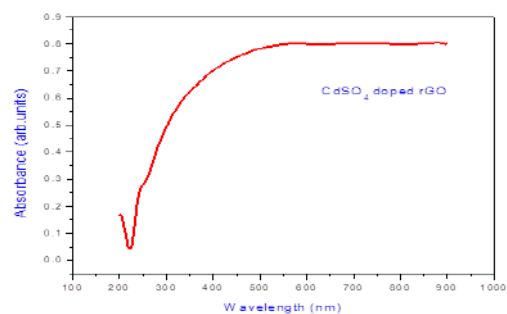
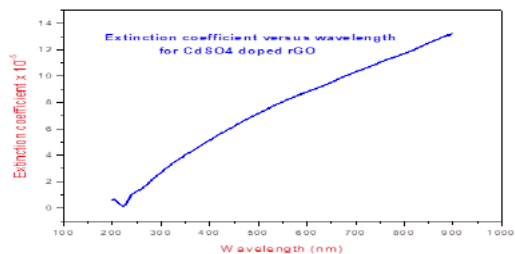
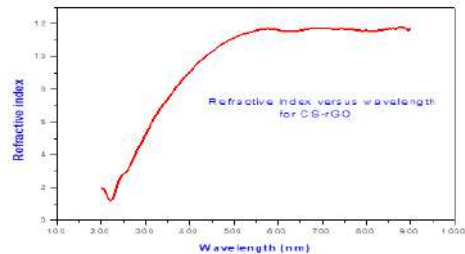
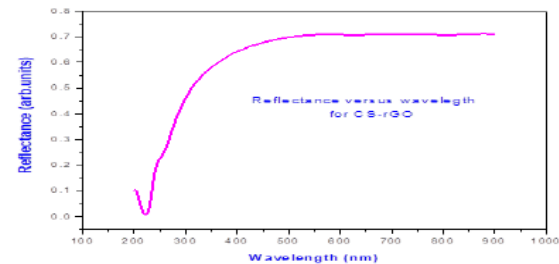
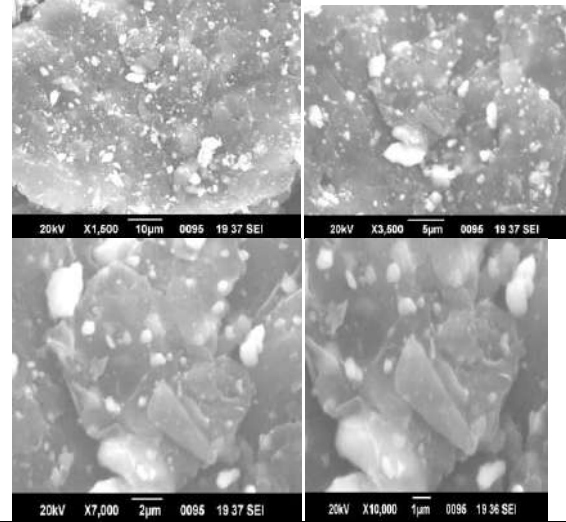
Figure 1: Synthesized GO solution and GO powder

Figure 2: Synthesised CdSO₄ doped rGO powder





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Figure 3: FTIR spectrum for CdSO₄ doped rGO nanomaterialFigure 4: UV-visible absorption spectrum of CdSO₄ doped rGO nanomaterialFigure 5: Plot of extinction coefficient versus wavelength for CdSO₄ doped rGO nanomaterialFigure 6: Plot of refractive index versus wavelength for CdSO₄ doped rGO nanomaterialFigure 7: Plot of reflectance versus wavelength for CdSO₄ doped rGO nanomaterialFigure 8: SEM images of CdSO₄ doped rGO nanomaterial



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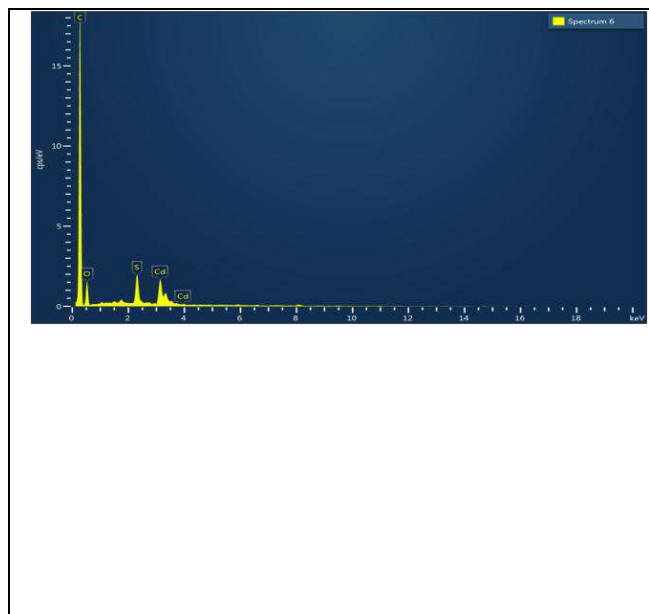


Figure 9: EDAX study for CdSO_4 doped rGO nanomaterial

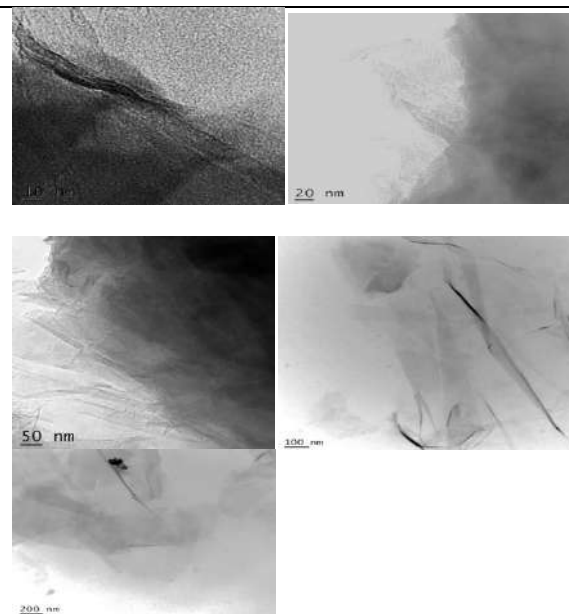


Figure 10: TEM images of CdSO_4 doped rGO nanomaterial

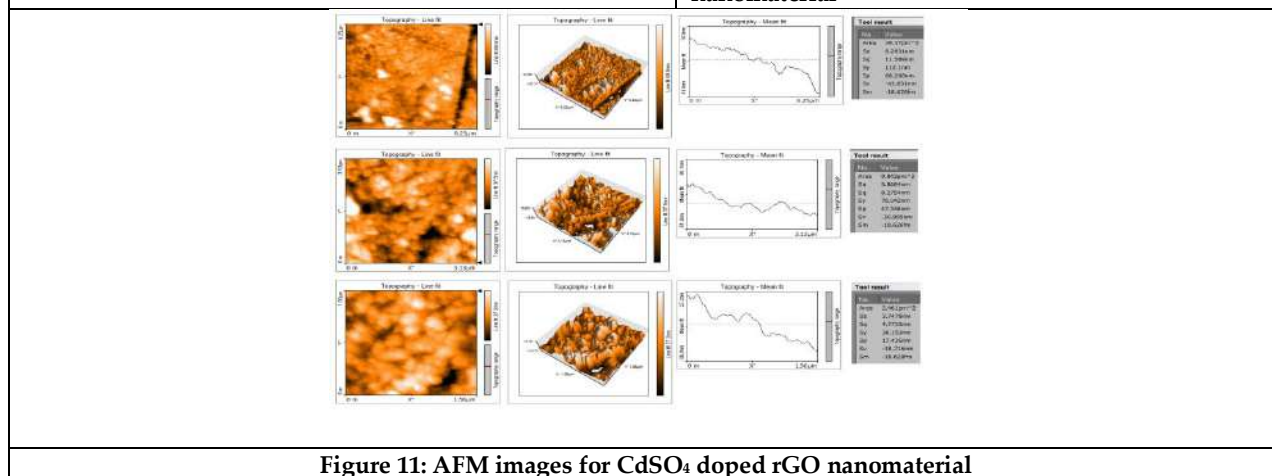


Figure 11: AFM images for CdSO_4 doped rGO nanomaterial





The Effect of Integrated Nutrient Management Approach in Vegetable Crops

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ABSTRACT

Integrated nutrient management (INM) provides a good opportunity to increase vegetable and crop production. INM is a good source to maintain soil fertility power and basic nutrient supply of plants to increase vegetable production through optimization of benefits from all origins of all essential nutrients of plants. Integrated Nutrient Management (INM) is a scheme under which the safest system for the decomposition of vegetable residues is so that the balanced and integrated use of organic and chemical fertilizers to maintain the nutrient and soil fertility power for the vegetable. By which high quality fertilizer can be produced and the yield of vegetables and crops increase. Integrated nutrient management involves providing the plant with an optimal level of nutrients needed to keep yield and productivity at a good level. A variety of organic materials such as farm yard manure (FYM), compost, vermi-compost, green manure, crop residues, and industrial wastes have been used in vegetable systems to provide essential nutrients to plants.

Keywords: INM, Vegetable, organic, FYM

INTRODUCTION

Vegetables are widely acknowledged as a crucial supplement for maintaining excellent health and ensuring nutritional security. They are important sources of vitamins, minerals, carbs, proteins, and roughages. An individual's daily need for a balanced diet may be easily satisfied by eating 125 grammes of leafy vegetables, 100 grammes of root and tuber vegetables, and 75 grammes of miscellaneous vegetables per day. Radish, carrot, chilli,



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cabbage, and other vegetables serve an important function in delivering nutrients to humans. Organic matter such as FYM, vermicompost, and chicken manure are now required for integrated nutrition management. Chemical and fertilizer-based agricultural technologies have been introduced to meet the ever-increasing demands for food supply from an ever-increasing population Kumar et al. (2020). The organic production system aims at supporting and sustaining healthy ecosystems, soil, farmers, food production, the community, and the economy. Reduction and elimination of the adverse effects of synthetic fertilizers and pesticides on human health and the environment is a strong indicator that organic agriculture is gaining worldwide attention. Organic fertilizers are environmentally friendly, since they are from organic sources Islam et al. (2017). India has emerged as the second largest producer country in the world. The current level of vegetable production is not complete with increasing population.

The level of vegetable production is convenient at the present time, but keeping in mind the future demand, we will require good resource management. It is estimated that in the year 2025, vegetable need / require will be 225 million tonnes against the limit of increase of cultivable area Bhat et al. (2018). So, all the need to fulfillment of higher yield production of vegetables and crop also, we should be going to INM approach. In present day, heavy doses of chemical products are used by farmers for getting higher yield but these synthetic products decrease the soil fertility, causes effects on both environment and human health. Therefore, Integrated nutrient management creates a good platform for future vegetable production, crop production and soil fertility, which supplies the essential nutrients of crops, Nutrient supply, Can be done with organic manure, compost / vermi-compost, crop residues, green manure, bio-fertilizer etc. Integrated nutrient management (INM) provides a good platform to increase soil fertility and crop productivity. Maintain required crop production through development of profit from all sources of plant nutrients in an incorporated manner adjustment or maintenance of mud fertility Kumar et al. (2019). Vermicompost is known as a good soil fertilizer that makes it the best organic soil fertilizer and more environment friendly than inorganic fertilizers. It can raise the amount of production of fruits and vegetables and save them from harmful pest and disease without polluting the environment Joshi et al. (2015).

Why INM is need in vegetable crops

The texture of the soil is deteriorated as a result of continuing use of chemical fertilizer. The recent high fertilizer amount and less receives power of the agricultural community has made it necessary to rethink about alternatives. Unlike inorganic- organic fertilizer are available locally at lower rate Kumar et al. (2018).

Concept of Integrated nutrients management

These continuous and disequilibrium use of fertilizer is more affect the agricultural growth. The major cause for the agricultural production would be management of soil organic carbon and balanced use of organic inputs such as crop residues, animal manure, folic acid, green manure also known as integrated plant resource management. Since bio- manure cannot fulfill the total nutrient requirement of new agriculture, hence integrated use of nutrient from bio sources and fertilizer would be the need of the time.

Components of Integrated nutrient management

Organic Manure

One of the most important and frequently used organic fertiliser components in INM is organic manures. Farmyard manure, compost, vermin compost, sheep dung, chicken manure, night soil, oil cakes, and animal excrement are all examples of organic manures. According to estimates, India produces 17.82 million tonnes of organic manures per year, which is 8.0 million tonnes less than what is needed to produce 2.30 million tonnes of food. Organic manures' nutrient content cannot be compared to that of inorganic fertilisers. However, compared to other nutrient sources, poultry manure, vermicompost, and oil cakes all contribute significantly to preserving soil fertility by altering the physico-chemical composition of the soil Bhat et al. (2018).

Farm yard manure (FYM)

It is composed of dung and urine of animals. FYM is applied to vegetable crops as organic manure. Since there are many helpful microorganisms in FYM that secrete chemicals that act as growth regulators and promote soil structure



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or soil fertility as well as plant growth, FYM provides all of the needed nutrients to the plant. Additionally, it is enhancing microbial activity, cation exchange capacity, and water holding capacity. It contains, on an average NPK (0.5%, 0.2%, and 0.5%) Rani et al. (2021)

Compost

It is developed after decomposed of bio- matter is called compost. Farm wastes like paddy straw, mustard stump or other like materials are commonly used by farmer for making compost. In difference, compost made from Night soil is known as town compost. Farm compost contains NPK 0.5 %, 0.5 %, and 0.5 %. Town compost are contains NPK (1.4 %, 1.00 %, and 1.4 %).

Vermi-compost

These are developed using Earthworm. The earthworm consumes organic matters and excretes it as cast. This cast use as vermin-compost. On an average it contains NPK (3 %, 1 %, and 1.5 %)

Bio fertilizer

Azotobacter and Phosphate solubilises these two are the main bio-fertilizer in vegetables cultivation. Azotobacter is independent nitrogen fixing bacteria which fixes 25- 30 kg N/hect. It also produces hormone like Indole Acetic Acid and Vitamins like biotin and B-group is also formed. The application of azotobacter with organic matter ensures good germination, development and production.

Inorganic fertilizer

It is an inorganic matter which is manufacture unnaturally. Fertilizers are affluent resource of nutrient and use in growth and crop production to supply a main nutrient in soil is scarce. It is very fast release the nutrient and help in early establishments and development of plants.

Goals of Integrated nutrient management

1. To cut expenditure on cost of by use farm bio manure and crop residue etc.
2. To use the potential profit of bio manures and crop residue.
3. To prevent loss of the nature.
4. To meet the socio-economic necessity of the farmer without harms the base of soil. Vinay et al. (2020).

Advantages of Integrated Nutrient Management:

1. Integrated nutrient management is economically profitable.
2. Helps in the management of nutrient, benefiting the earth productivity via favourable impact on biological properties of soil.
3. It give guarantee to regular supply of secondary nutrients
4. The quality and yield are improved due to their positive effect on soil properties.
5. INM not only raise the production but it also helps in maintain the soil fertility.
6. INM increased the yield of crops but has exhibited beneficial residuary impact on crops.

CONCLUSION

The strapping and over usage of in organic fertilizers had effected, human and soil health, besides creating serious effect of environmental pollution. The farmers are also seeing for lower cost input alternative mainly of NPK fertilizer, which constituted a main component. Hence the use of INM becomes crucial for higher vegetable and crop production, soil health and quality. In future, produce more vegetables for increasing population under limited plant resource. Sustainability advocates an integrated use of various production resources in a manner to description





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productivity on another to protection earth health and quality. The high crop produces through INM will not only be higher in bulk but also rise in quality in terms of nutrition.

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INM in some commercial vegetable crops

Crop	INM Option	
Brinjal (<i>Solanum melongena</i>)	75% recommended dose of fertilizers + FYM @ 7.5 t ha ⁻¹ + pressmud @ 4.5 t ha ⁻¹ + vermicompost @ 1.5 t ha ⁻¹ + biofertilizers (Azospirillum and Phosphobacteria) can be resorted to, for higher yields and quality of brinjal.	Poonkodi et al. (2019)
Tomato (<i>Lycopersicon esculentum</i>)	Application of FYM @ 8t/ha gives highest yield production (9.57t/ha)	Hussein et al. (2018)



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Bell pepper (Capsicum annum)	Basal applications of N equivalent (150 kg/ha) through 50 % each FYM and poultry manure were found most superior in improving the physicochemical properties of the soil.	Ganiger et al. (2012)
Okra (Abelmoschus esculentus)	Highest yield of okra was recorded in the treatment comprising 100% recommended NPK + vermicompost @ 10 t ha ⁻¹ ,	Sharma et al.(2009)





RESEARCH ARTICLE

The Relationship of Social Media Addiction, Online Impression Management and Fear of Missing out in Indian Youth

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ABSTRACT

Humans have basic desire for connection, and interpersonal contact is necessary to meeting these needs. Interpersonal communication has seen a transformation in recent years as a result of the rise of technological advances, particularly the growth of social media. People who communicate online, just like those who do so in person, are always looking to learn more about one another so that they may anticipate what to expect and how to respond. People may be planning their actions and behaviors deliberately or unconsciously because they want to control the impressions they are about to give others. They spend more time on platforms because they are concerned about losing out on new advancements causing them to experience FOMO. The aim of this research was to test the relation of social media addiction with online impression management and FOMO. A survey was administered collecting the data of 130 young adults. After conducting a correlation analysis, a strong relationship was discovered among the variables.

Keywords: Social media addiction, online impression management, FOMO, social media, young adult

INTRODUCTION

Social networking sites (SNS) are networks in which people may make online profiles of them, interact with friends, and connect with individuals who share their passions. SNSs are “web-based services that allow individuals to: construct a public or semi-public profile within a bounded system, articulate a list of other users with whom they share a connection, and view and traverse their list of connections and those made by others within the system”[1].



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Instead of networking, which calls for the creation of fresh networks, the emphasis is on existing networks. In 1997, the first SNS called “Six Degrees” was released. In 2004, “Facebook” was created as a private online community for the students of Harvard but it soon became available and popular worldwide. Similar to addictions to other substances, SNS addiction includes the signs of dependency such as “modifying one’s mood” (using SNSs results in a positive change in sentimental conditions), “salience” (preoccupation with the SNS usage), “tolerance” (constantly using SNSs), “withdrawal symptoms” (experiencing uncomfortable emotional and physical symptoms when SNS use is restricted), and so on. Additionally, researchers have proposed that the etiology of addictions is influenced by a variety of “biological, psychological, and social” variables [2, 3], and this may also be relevant to SNS addiction. In this study, we will be focusing on “fear of missing out” (FOMO) which is a psychological perspective, “online impression management” (OIM) which is a social perspective and their relationship with “social media addiction” (SMA).

Social Media Addiction

SMA may be observed as a type of “Internet addiction” where people have an excessive need to utilize SNS [4]. People who have this addiction display excessive anxiety and are prompted by an overwhelming feeling to access and utilize SNS [5]. According to findings, SMA indicators might include issues with mood, cognitive, bodily symptoms and mental health issues. Numerous researches on the link among SNS use and psychological health showed that extended usage is detrimental to overall wellness as well as related to psychological conditions like anxiety, depression, and distress [6, 7, 8, 9]. Among college kids, SNS use was strongly correlated with signs of depression [10,11]

Online Impression Management

“Virtually everyone is attentive to, if not explicitly concerned about how he or she is perceived and evaluated by other people” [12], the act of impression management is based on this concern. To understand “theatrical performances” we engage in during regular social contact to influence how others see us, Goffman developed the theory of impression management [13]. It asserts that individuals make an effort to control how others see them by controlling their behavior and language. Because SNSs, like Facebook and Instagram are devoted to establishing and controlling impressions along with participating in relationship maintenance and relationship-seeking behaviors, they are of significance for researchers [14].

Fear of Missing Out

“Fear of Missing Out” also known as FOMO is defined as, “a pervasive apprehension that others might be having rewarding experiences from which one is absent, and it is characterized by the desire to stay continually connected with what others are doing” [15]. High FOMO individuals need frequent social interaction and knowledge about what other individuals are up to [16, 17]. A fundamental psychological desire that governs how people act is an urge to fit in, to feel near to and linked to people [18]. According to research [15], one’s FOMO tends to rise if their psychological demand for connection isn’t being met. SM, which allows users to constantly keep in contact with their peer group, serves as a handy outlet for this increased FOMO.

Hypotheses

H1: There will be a significant positive correlation between Online Impression Management and Social Media Addiction

H2: There will be a significant positive correlation between Fear of Missing Out and Social Media Addiction

METHODOLOGY**Materials**

SMA was measured using the, “Social Media Addiction Scale” developed by Şahin [19]. The measure consisted of 29 questions. The second scale used to measure OIM was “Presentation of Online Self Scale (POSS)” made by Fullwood and colleagues [20]. Scale consists of 21 questions. FOMO was measured by “Fear of Missing Out Scale: FoMOs”





developed by Przybylski and colleagues [15]. The measure has 10 questions. The responses of all the scale were recorded on a likert scale of 5 point. The scales consisted of good reliability and validity [15,19,20].

Sample and Data Collection

The sample of the study consists of young-adult age group from India. Convenience sampling technique was used in this research. Data was collected using Google forms. The form was prepared using the scales and contained instructions on how to response. A total of 130 participants consented to being part of the study out of which 70 participants were females and 60 were males.

Statistical Method

Descriptive Statistics and Correlation was employed in the study. 0.01 level was used to test the significance.

RESULTS

In the result tables displayed, SMA is “social media addiction”, OIM is “online impression management” and FOMO is “fear of missing out”. The mean, SD, minimum and maximum values of the variables are displayed in Table 1. The inter-correlations among the variables are displayed in Table 2. There is correlation between SMA and OIM at .740 and between SMA and FOMO at .532 as per the analysis.

DISCUSSION

While the consequences of “Internet addiction” have been thoroughly studied across many years, research on SNS and its related categories has only recently begun. Despite several signs of addiction, such as unfavourable effects, fixation, and withdrawal, a review of SMA studies in 2014 concluded that its validity was still up for question [8]. The objective of this study was to examine the relationship of SMA with OIM and FOMO. To investigate this, a quantitative research was carried out. This method of research is concerned with collecting and analyzing data and then presenting it numerically [21]. Data was gathered with the use of Google forms. 130 people participated in the study. The collected data was analyzed using SPSS. The mean and SD for SMA was 72.26 and 17.36, for OIM was 52.63 and 10.84 and for FOMO was 19.12 and 7.31 respectively. To determine the relationship between SMA, OIM and FOMO a test of Pearson correlation was conducted. Correlation is defined as, “a relation existing between phenomena or things or between mathematical or statistical variables which tend to vary, be associated, or occur together in a way not expected by chance alone” [22]. Pearson is a type of bivariate correlation that examines relation among two variables. Correlation between SMA and OIM was at .740 which means it is a significantly positive relationship which confirms H1. In order to manage impression, people engage in the usage of SNS more than they should which causes both variables to move in the same direction. Similar results were found in researches conducted previously where OIM was strongly connected to SMA [23,24]. The correlation between SMA and FOMO was at .532 which means it is a significantly positive relationship which confirms H2. People experience apprehension on missing out any information on SNS. They constantly use their accounts to stay updated which is why both variables move in the same direction. Previous studies have found similar results suggesting a good relation among SMA and FOMO [25, 26].

CONCLUSION

The goal of this paper was to determine the relationship of SMA with OIM and FOMO. As per the analysis conducted, a strong correlation was found between the variables. Researchers should further investigate in this field since SNS is a fast growing phenomenon in these times of advanced technology. The area of research should be broadened to deeply understand the effects of these variables on the overall well-being of people.





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Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SMA	130	29	145	72.26	17.368
OIM	130	33	97	52.63	10.841
FOMO	130	10	50	19.12	7.319
Valid N (listwise)	130				

Table 2: Correlations

		SMA	OIM	FOMO
SMA	P Correlation	1	.740**	.532**
	Sig. (2-tailed)		.000	.000
	N	130	130	130
OIM	P Correlation	.740**	1	
	Sig. (2-tailed)	.000		-
	N	130	130	
FOMO	P Correlation	.532**		1
	Sig. (2-tailed)	.000	-	
	N	130		130

** . Correlation is significant at the 0.01 level (2-tailed).





A Study on Consumer Perception towards Organic Products in Coimbatore City

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ABSTRACT

This study attempted to gain knowledge about consumer perception towards organic products consumption and how socio-economic variables related to consumer decision-making while purchasing an organic food. The primary data will be used from selected consumers on Simple Random sampling techniques, with the help of questionnaire. According to the findings, the majority of consumers, particularly those living in cities, Choose an organic food product. Promotion of organic products are in short supply in the research area, there is a high demand for them. The main reasons are a lack of organic producers, a lack of suitable market facilities, a small number of retailers, a lack of knowledge, and so on

Keywords: Organic products, consumer satisfaction, Usage, Perception.

INTRODUCTION

There's no common description of "organic" due to the fact that different countries have different standard for products to be certified "organic". In simplest words organic foods are minimally reused to maintain the integrity of the organic without artificial constituents, preservatives or irradiation. Organic products are attained by processes friendly to the terrain, by civilization ways that consider both the attributes of the final product and the product styles. A wide range of consumers of organic product were addressed and scanned to gain their compliances and fancies towards organic products. All organic products consumers aren't having the same system of approach towards organic food. latterly the statistical process guides us to comprehend the relation and the model of the consumer gets trends in organic food in India. The description of the word "Organic", an ecological operation product system that promotes and enhances biodiversity, natural cycles and soil natural exertion. Ajzen and



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Fishbein(1980), in their study, mention that ‘consumers with a positive station ’ towards organic foods might not inescapably show an intention to buy them; also, consumers don't agree to pay a decoration price for organic food products(Grunert & Juhl, 1995). On the other hand, some exploration regarding green consumers tries to explore the contributing motives in order to prognosticate consumer opinions and intentions to buy organic products. The most astronomically anatomized motives and factors affecting consumer purchases of organic products are health(Ghali-Zinoubi & Toukabri, 2019), environmental issues(Kim & Choi, 2005; Mei, Ling, &Piew, 2012; Prakash, Singh, & Yadav, 2018), produce safety, and its quality(Ghali- Zinoubi&Toukabri, 2019). Health issues are the main motive in some experimenters’ works. Sumathi and Gabriel(2017) argue that consumers perceive organic products as environmentally-friendly food products; similar food products are fresh, aseptic, and healthy. For the once many times, people have come more health-conscious and started approaching dietitians, nutritionists, gymnasiums, etc. The raised concern to maintain a healthy life has also shaped consumer stations towards food; thus, food without unsafe complements, preservatives, flavor and coloring has come popular(Shaharudinetal., 2010). According to a recently forming perception, aseptic and nutritive food gave good results for mortal 274 Exploring the Link Between Entrepreneurial Capabilities, Cognition, and Actions Marta Gancarczyk& Anna Ujwary- Gil(Eds.)

OBJECTIVES OF THE STUDY

1. To understand the consumer ‘s knowledge, perception and attitude towards organic products.
2. To analyze the factors influencing consumer behavior towards organic products.
3. To examine the consumers ‘willingness to pay for organic products

METHODOLOGY

The study is based on primary study. The primary data will be used from selected consumers on Simple Random sampling techniques, with the help of questionnaires. A sample of 30 consumers of organic products in Coimbatore city. To understand the demand factor in organic products and the consumers’ perception towards it in Coimbatore city.

DATA ANALYSIS AND INTERPRETATION

The above table 1 reveals that the 50 percent of Respondents were belonging to Male, remaining of the 50 per cent of the respondents were Female. Both male and female respondents were purchased organic products. The table 2 shows that 63.3 % of the respondents are married, 30% of respondents are unmarried, 6.7 % of respondents are widow. The table 3 shows that preferences for organic products among respondents in the study area. All the respondents preferred organic products and they are consuming the same, in the opinion that using of organic products, maintenance of good health. From the above table it is found that most of the respondents are aware of the organic products. Few respondents were not aware of organic products because the reasons for consuming organic products are credibility and availability.. The above table representing that 80% of respondents are satisfied in using organic products. 20% of respondents are not satisfied because of more expensive to buy the organic products than non-organic products. Many people believe that organic products do not allow the use of ant chemical. From the above table it is found that 63.3 % are afford to buy the organic products, but 36% of respondents can't afford for organic products due their less income. The table 7 represents 66.7 % respondents are gained Good Experience in the usage of an organic products in their daily basis, 16.7 % not satisfied, 16.7 % respondents are not experienced in using organic products. The table 8 shows that 43.3 % of respondents are using organic products, 20% of respondents are not experience is using organic products it is seen that the consumers prefer to buy organic food products, there are various factors impacting the preference. The table explains whether there is opinion on organic products, 13.3 % respondents said is only average opinion on organic products, 50% of respondents said that it is affordable to use the products, 36.7 % said its id costly to buy the organic products, hence it is based on their experiences to use the organic products. The table explains that the 43.3 per cent of the respondents said they are purchasing the organic



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product, monthly once, 26.7 per cent respondents are buying 6 month once and few respondents are not using the organic product in their lives.

FINDINGS

The above analysis inference was drawn and the findings emerged out of study are:

- In this study both male and female respondents were purchased organic products.
- Most of the respondents are married i.e.63.3 %.
- All the respondents preferred organic products and they are consuming the same, in the opinion that using of organic products, maintenance of good health.
- It is found that most of the respondents are aware of the organic products. Few respondents, they are not aware of organic product.
- Majority of respondents are satisfied in using organic products, for their healthy life.
- Our study shows that 63.3 % are afford to buy the organic products.
- It revealed that most of the respondents said that 66.7 % experienced in using the organic products in their daily basis.
- Majority of respondents are using organic products in their daily basis for healthy life.
- Only 50 per cent of respondents said that it is affordable to use the products.
- Most of the respondents are said they are purchasing the organic product monthly once, because the product demand is increasing and cost also increased.

CONCLUSION

Thus, this study concluded that consumer behaviour is important when purchasing any product, not only organic products. So the supply of organic shops and products is limited, but the demand for it is high, so farmers and the government are thinking about improving or growing production of organic et system, which helps to enhance the standard of living for farmers while also being beneficial for the environment. The sale of organic products is on the rise. Organic food marketers must be imaginative and dynamic in order to keep up with the changing purchasing habits of urban inhabitants in the Organic food goods market.

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Krishnaveni *et al.*,**Table 1: The Classification of Respondents Based on Gender**

Gender	Frequency	Percent
Male	15	50.0
Female	15	50.0
Total	30	100.0

Source: Primary data

Table 2: The classification of Respondents on their Marital Status

Marital status	Frequency	Percent
Married	19	63.3
Unmarried	9	30.0
Widow/Separated	2	6.7
Total	30	100.0

Source: Primary data

Table 3: Preference for Organic products, among respondents

Preference organic product	Frequency	Percent
Yes	30	100.0
No	0	0
Total	30	100.0

Source: Primary data

Table 4: Aware of Organic products, among respondents

Aware of organic food	Frequency	Percent
Yes	26	86.7
No	4	13.3
Total	30	100.0

Source: Primary data

Table 5: Satisfaction of Organic products, among respondents

Satisfaction	Frequency	Percent
Yes	24	80.0
No	6	20.0
Total	30	100.0

Source: Primary data

Table 6: Affordable of Organic products, among respondents

Affordable	Frequency	Percent
Yes	19	63.3
No	11	36.7
Total	30	100.0

Source: Primary data

Table 7: Experience in Organic products, among respondents

Experience	Frequency	Percent
Good	20	66.7





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Satisfied	5	16.7
No Experience	5	16.7
Total	30	100.0

Source: Primary data

Table 8: Usage in Organic products, among respondents

Usage	Frequency	Percent
Good	13	43.3
Satisfied	4	13.3
Comfortable	7	23.3
No Experience	6	20.0
Total	30	100.0

Source: Primary data

Table 9: Opinion on Organic products, among respondents

Opinion	Frequency	Percent
Average	4	13.3
Affordable	15	50.0
Costly	11	36.7
Total	30	100.0

Source: Primary data

Table 10: Purchasing of Organic products, among respondents

Purchasing	Frequency	Percent
Weekly	4	13.3
Monthly	13	43.3
6Months Once	8	26.7
Not Yet Used	5	16.7
Total	30	100.0

Source: Primary data





RESEARCH ARTICLE

Qualitative and Quantitative Analysis of the Unexplored fern, *Thelypteris meeboldii* from Southern Western Ghats, Tamil Nadu

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ABSTRACT

The present study was to screen the presence of phytochemicals in the petroleum ether, chloroform, ethyl acetate and methanol of fern *Thelypteris meeboldii* species by composed with qualitative and quantitative screening methods. In qualitative analysis, the presence of pharmacologically active phytochemicals such as alkaloids, flavonoids, glycosides, steroids, tannins, terpenoids, saponins, phenols, volatile oils and resins were screened. The methanol fern extract performed well to show positivity rather than other studied fern extracts. Methanol extract showed strong positivity for 6 phytochemicals out of 10 phytochemicals tested. In quantitative analysis the important secondary metabolites such as total phenols, total tannins, total alkaloids, total flavonoids, total saponins and total terpenoids content were quantified.

Keywords: phytochemicals, qualitative, quantitative, *Thelypteris meeboldii*, methanol.



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INTRODUCTION

Pteridophytes are an old class of non-seed-bearing plants that are considered to be important in biogeography due to the abundance of extinct and endemic taxa they include. The pteridophytes are typically found in a latitudinal gradient, with the largest diversity occurring primarily in mountainous regions of the tropics (Kornas, 1993). They have a small distribution in temperate zones and are mostly found in tropical and subtropical climates (Pallavi *et al.*, 2011). Ferns have observable characteristics that could reveal how environmental changes have an impact on them. The ferns are plants with a dynamic link to their environment in addition to being taxonomically peculiar (Verma and Khullar, 2010). More than 2,000 years of human history have seen the use of plants as folk medicine and there is a wealth of literature on the therapeutic value of different fern species (Kirtikar and Basu, 1935; Nayar, 1957; Chopra *et al.*, 1958; Kumar and Roy, 1972; Watt, 1972). Seldom have systematic studies of fern's therapeutic uses been conducted that are not pharmacologically assessed (Kandhasamy *et al.*, 2008; Kaushik and Dhiman, 1995; Dixit and Bhatt, 1974; Manickam and Irudayaraj, 1992). There is a huge demand for exploitation of pteridophytes for their economic utility in day-to-day life because of their enormous economic importance (Benjamin and Manickam, 2007). Within the recent years, infections have increased to a great extent and the infection causing microbes developed resistance to therapeutics, such as antibiotics and antimicrobial drugs, has increased the demand for more effective antimicrobial agents. Various groups of medicinal plants have a potential to cure different disorders such as cuts, burns and skin diseases, which is due to their antimicrobial activities. The use of the extracts of these medicinal plants alone, or in combination with the available antibiotics, might contribute to more successful treatment of infections induced by multi drug resistant microorganisms. Recently, some fern species (Pteridophytes) have been identified to possess therapeutic potential, mainly due to the presence of various bioactive phytochemicals, such as phenolics and steroids (Ho *et al.*, 2010; Chai *et al.*, 2013; Antony *et al.*, 2014, 2020). Therefore, it is of great interest to carry out a screening of the selected fern species in order to validate their use in folk medicine. Systematic screening of them may result in the discovery of novel active compounds.

MATERIALS AND METHODS

Collection and Identification of Plant materials

Healthy and matured plant material for the present study was collected from Valparai Hills, Western Ghats. The collected specimen was identified and authenticated by Dr. M. Johnson, Director, Centre for Biotechnology, St. Xavier's College, Palayamkottai, Trichy with reference no (CPB2095). The collected specimen was identified as *Thelypteris meeboldii* (Rosenst.) Holttum.

Preparation of sample

The fronds of selected fern used for phytochemical screening were washed multiple times with tap water and further with distilled water to remove fine impurities. Leaves were shade-dried for 30 days to remove all the moisture content and to preserve maximum of the bioactive compounds. The dried fronds were cut down into small pieces of size up to 1-2 cm. The cut down parts were crushed using a laboratory blender and then sieved through a mesh size of 3 mm in order to remove the coarse materials. The fine powder was then packed in an airtight container, labelled and stored for further studies.

Preparation of extract

Organic solvents in the increasing order of polarity (Petroleum ether, Chloroform, Ethyl acetate, Methanol) were used to extract the powder sample of *Thelypteris meeboldii* according to the method described by Harbone, 1998. The sample were sequentially extracted using a soxhlet apparatus at a temperature (40-50°C) and was subjected to detect the presence of different phyto constituents.



Sowmiya *et al.*,**Qualitative phytochemical screening**

Phytochemical screening of the extracts was carried out according to standard procedure. The Qualitative phytochemical analysis was carried out for the frond extract of *Thelypteris meeboldii* according to the polarity to identify the phytochemicals present in the different extracts. The tests performed were alkaloids, glycosides, volatile oils, steroids and resins (Shakoor *et al.*, 2013); phenols, flavonoids and saponins (Kalpana Devi *et al.*, 2014); tannins, anthraquinones and terpenoids (Shinde *et al.*, 2016).

Quantitative phytochemical screening

Alkaloids, Phenols, Tannins, Flavonoids, Saponins and Terpenoids reported in the methanolic extracts of *T.meeboldii* was quantified using the following standard procedures.

Determination of total alkaloids

5 g of the sample was weighed into a 250 ml beaker and 200 ml of 10% acetic acid in ethanol was added and covered and allowed to stand for 4 h. This was filtered and the extract was concentrated on a water bath to one-quarter of the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until the precipitation was complete. The whole solution was allowed to settle and the precipitated was collected and washed with dilute ammonium hydroxide and then filtered. The residue is the alkaloid, which was dried and weighed (Harborne 1973). Triplicate results were recorded.

Determination of total phenols

100 mg of the extract of the sample was weighed accurately and dissolved in 100 ml of triple distilled water (TDW). 1 ml of this solution was transferred to a test tube, then 0.5 ml 2N of the Folin-Ciocalteu reagent and 1.5 ml 20% of Na_2CO_3 solution was added and ultimately the volume was made up to 8 ml with TDW followed by vigorous shaking and finally allowed to stand for 2 hours after which the absorbance was taken at 765 nm. The results were expressed in mg of gallic acid equivalent (GAE) per g of dry weight of plant powders (Hagerman *et al.*, 2000).

Determination of total tannins

Tannin content of the methanol extract of the fern was estimated by following the standard procedure (Hagerman *et al.*, 2000; Fagbemi *et al.*, 2005). The 1 ml of methanol fern extract was mixed with Folin-Ciocalteu's reagent (0.5 ml), followed by the addition of saturated Na_2CO_3 solution (1 ml) and distilled water (8 ml). The reaction mixture was allowed to stand for 30 min at room temperature. The supernatant was obtained by centrifugation and absorbance was recorded at 725 nm using UV-Visible Spectrophotometer. Increasing concentrations of standard tannic acid was prepared and the absorbance of various tannic acid concentrations was plotted for a standard graph. The tannin content was expressed as mg tannic acid equivalent per 100 gram of the sample.

Determination of total flavonoids

The method is based on the formation of the flavonoids –aluminium complex which has an absorptivity maximum at 415 nm. 100 μl of the plant extracts in methanol (10 mg/ml) was mixed with 100 μl of 20% aluminum trichloride in methanol and a drop of acetic acid, and then diluted with methanol to 5 ml. The absorption at 415 nm was read after 40 minutes. Blank samples were prepared from 100 ml of plant extracts and a drop of acetic acid, and then diluted to 5 ml with methanol. Increasing concentrations of standard quercetin solution was prepared and the absorbance of various quercetin concentrations was plotted for a standard graph. All determinations were carried out in triplicates (Kumaran and Karunakaran, 2006).

Determination of total saponins

An amount of 10 g of each extract was taken and 50 ml of 20% aqueous ethanol was dissolved. The samples were heated and continuously stirred for four hours at 55°C under water bath. The mixture was filtered and the residue re-extracted with another 200 ml 20% ethanol. The combined extracts were reduced to 40 ml over water bath at about 90°C. The concentrate was transferred into a 250 ml separatory funnel and 20 ml of diethylether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process



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was repeated. 60 ml of n-butanol was added. The combined n-butanol extracts were washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation the samples were dried in the oven to a constant weight; the saponin content was calculated (Obdoni and Ochuko, 2001).

Determination of total terpenoids

Powder form of 10 g of each extract was soaked in alcohol for a day. Later on it was filtered and petroleum ether was used for purpose of extraction. The extracted material was calculated and considered as terpenoids (Sharma *et al.*, 2015).

RESULTS AND DISCUSSION

Qualitative phytochemical analysis

The study was undertaken to evaluate the phytochemical constituents of the selected fern extract of *T. meeboldii* to confirm the presence of bioactive compounds. The phytochemical test was conducted using different solvents based on the increasing order of polarity such as Petroleum ether, chloroform, ethyl acetate and methanol. The preliminary phytochemicals of *T. meeboldii* were recorded and tabulated. Panda *et al.* (2014) screened the phytochemicals of *Thelypteris interrupta* commonly found in Odisha using methanol and chloroform as solvent. Methanol extracts showed the presence of major phytoconstituents such as alkaloids, tannins, anthroquinone, steroids and terpenoids as compared to chloroform. Rekha (2017) did preliminary phytochemical analysis on the fern, *Christella dentata*. Aqueous and ethanolic extracts of leaves, petiole and rhizome of *Christella dentata* revealed the presence of various metabolites like ketose, carbohydrate, protein, cardiac glycosides, steroids, flavonoids, phenols, saponin, terpenoids, alkaloids, tannin, coumarin, acids and quinone. Occurrence of different secondary metabolites and their concentration was much lesser in the leaves. Rhizome revealed the presence of most of the metabolites analysed and at higher concentrations. Shubhangi *et al.* (2018) studied the phytochemicals of *Christella dentata* leaf using methanol as solvent. The phytochemicals such as alkaloids, flavonoids, phenols, phytosterols, saponins, tannins and mucilages were found to be present and terpenoids and steroids were found to be absent. Vijayakumari *et al.* (2022) evaluated the phytochemicals of aerial part of *Christella parasitica* using petroleum ether, ethyl acetate and distilled water as solvents. Steroids, tannins, quinones, terpenoids, phenols and phlobatannins were present in all the extracts. Alkaloids, saponins, flavonoids and glycosides were absent in distilled water. Similar result was recorded in our present study that the methanolic extract of *T. meeboldii* showed the presence of seven phytochemicals *viz.*, alkaloids, phenols, flavonoids, saponin, terpenoid, resin and steroid whereas ethyl acetate extract showed six phytochemicals, chloroform extract showed five and petroleum ether showed only four phytochemicals.

Quantitative phytochemical analysis

The amount of phytochemicals which were found in the methanol fern extract was quantitatively determined by following standard procedure. Among the six phytochemicals quantified, alkaloid content was highest followed by phenol and flavonoid (Table 2). Ahmed *et al.* (2015) studied the total phenolic content and total flavonoid content in the methanolic extract of *Adiantum caudatum*. The total phenolic content of the methanolic extract of *A. caudatum* was 27.7 µg of gallic acid equivalents/ ml and the total flavonoid content was 13.2 µg of rutin equivalents/ ml. As phenolics (including many flavonoids) contain polar phenolic hydroxyl group/s, their high extraction into methanol is quite reasonable. The TPC is higher than the TFC, supporting the fact that most flavonoids are also phenolics. Madhav and Meena (2020) studied the quantitative estimation of phytochemicals from *Ampelopteris Prolifera* using hexane, chloroform, ethyl acetate, methanol and 50 % aqueous methanol as solvents. The highest amount of phenolic was detected in 50% methanol extract (114.27±10.37 mg GAE/g). The highest amount of flavonoid was detected in ethylacetate extract (151.47±3.57 mg CE/g extract). The highest amount of hydrolyzable tannin was detected in 50% methanol extract (31.21±2.14 mg TAE/g extract). The highest amount of condensed tannin was detected in ethylacetate extract (337.50±5.00 mg CE/g extract) and the highest amount of sugar was detected in methanol extract (809.74±7.86 mg GE/g). The present study revealed that *T. meeboldii* contains maximum amount of phenol, flavonoid and tannins and least amount of alkaloids. Tannins are known to possess antioxidant property, which is essential in





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protecting cellular oxidative damage. It was described that tannins enhance glucose uptake activity and inhibit adipogenesis, thus being potential drugs for the treatment of non- insulin dependent diabetes mellitus (Muthusamy et al., 2008).

CONCLUSION

The present study was proposed to investigate the secondary metabolites of *Thelypteris meeboldii*, a small to medium sized fern which belongs to the family Pteridaceae. The fronds of *T.meeboldii* were analysed for the phytochemicals. Preliminary phytochemical screening reported the presence of maximum phytochemicals in methanol extract. Due to the presence of maximum phytochemicals in the methanol extract, it was further preferred for quantitative analysis. It showed highest amount of phenols followed by flavonoid and tannin followed with least content of alkaloid and saponin. This study is an output for further research in application of this fern extract for antioxidant and anticancer property because of holding higher phenolic and tannin content. Isolation and identification of the active compound from the selected fern using chromatographic and spectroscopic techniques are essential for bringing promising drug to cure dreadful diseases.

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CONFLICT OF INTEREST

Authors declare no conflict of interests.

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Table: Qualitative phytochemical analysis of fern extracts

Phytoconstituents	<i>T. meeboldii</i>				
	Petroleum ether	Chloroform	Ethyl acetate	Methanol	Water
Alkaloids	-	-	+	+	+
Glycosides	-	+	-	+	+
Phenols	-	-	-	+	+
Tannins	-	+	-	+	+
Flavonoids	-	-	+	+	+
Saponins	-	+	+	+	+
Volatile oils	+	-	-	-	+
Terpenoids	-	+	-	+	-
Resins	-	-	+	-	-
Steroids	-	-	+	+	-

Table 2: Quantitative analysis of phytochemicals of methanolic fern extract

Metabolites	<i>T. meeboldii</i>
Alkaloids (mg/g)	8.41 ± 0.16
Total phenols (mg/g)	15.61 ± 0.18
Total tannin (mg/g)	12.59 ± 0.12
Total flavonoid (mg/g)	15.17 ± 0.04
Total saponin (mg/g)	5.32 ± 0.09
Total terpenoids (mg/g)	11.37 ± 0.08





Evaluation of Potential Role of Aqueous Leaves Extract of *Averrhoa carambola*

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ABSTRACT

Averrhoa carambola is known as tree. *Avera carambola* leaves are commonly used in Ayurvedic and traditional Chinese medicine used for inflammatory skin disorders and fungal skin infection. The leaves of star fruit are rich in vitamin C and bioactive compounds like phenols and flavonoids abundant source of antioxidant. The qualitative phytochemical study of this plant extracts indicates presence of tannins, saponin, flavonoids, alkaloids, proteins, phenol. The herb has been used traditionally from antiquity, in the treatment of neurological healthy and memory issues, breast cancer. It is chiefly possesses the pharmacological study of this plant explains about antibacterial, antioxidant, antifungal, anticatalytic, antiviral activities. The work is an endeavor to explore and to explore and assemble the various pharmacological action and pharmacogonostic aspects of the leaves *Averrhoa carambola* reported till date.

Keywords: Ayurvedic, Skin disorders, Fungal skin infection, Phenols, Flavonoids, Antioxidant.

INTRODUCTION

Averrhoa carmbola bioactive compounds are responsible for medicinal properties. *Avera carambola* has proved to be effective in curing multiple diseases. The percentage of antioxidant activity was assessed by DPPH and reducing power of extract was also determined. The bioactive compounds was analyzed in photochemical screening and antibacterial and antifungal activity was also determined. The project will be carried out on *Averrhoa carambola* as chemotherapeutic agent.



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Thus it can be started that this leaves is there suitable drug and can further explored and exploited to meet the global demand for natural, cost-efficient and safer bio active compounds. *Averrhoa carambola* showed that contained tannins, saponins, flavonoids, alkaloids, proteins, phenols. The pharmacological investigations revealed that they possessed antibacterial, antioxidant, anticancer and anti-depressant.

MATERIALS AND METHODS

Leaves of *Averrhoa carambola* leaves treated with cold extraction of pytochemical analysis.

Cold extraction

Ten gram of sample was weighed and soaked in 100 ml of aqueous. The extract was allowed to stand overnight and filtered using sterile filter paper. The filtrate was collected and incubated at room temperature for evaporation. Then measure the weight and find the yield by calculating.

Yield = Initial weight - Final weight

Aqueous extract [2.12 g/10 g leaves powder] and assay antioxidant and used the techniques is thin layer chromatography, analysis for flavonoids and treated with antioxidant activity antimicrobial activity such as antibacterial activity, antifungal activity and MIC assay.

RESULTS & DISCUSSION

The *Averrhoa carambola* leaves were extracted using aqueous. The yield was observed in aqueous extract (2.12 g/10 g leaves powder). Similarly, Shu *et al.* (2014) reported leaves and fruits from *A. carambola* (10 g) were extracted thrice with acetone: water (7:3). The final yield of acetone: water extracts (AWE) of leaves and fruits were 4.30 and 5.79 g, respectively. Phytoconstituents of the *Averrhoa carambola* aqueous extract of leaves were analyzed qualitatively. Our results showed the presence of tannin, saponin, flavanoid, protein, alkaloid and phenol in the aqueous extract. These secondary metabolites could be in source of the therapeutic effects. Ashim Pal *et al.* (2019) revealed that the preliminary phytochemical screening of the *Averrhoa carambola* aqueous extract contains tannins, flavonoids, phenols, terpenoids, sterols, fats, fixed oils *etc.* Our results showed that the analysis of antioxidant property in *Averrhoa carambola* aqueous extract of leaves exhibited IC₅₀ values at 500 µg for DPPH scavenging analysis and reducing power assay showed 165 µg/ml. Similarly, Henrique *et al.* (2012) studied *Averrhoa carambola* crude extract of leaves at 212 µg/g, Hexane extract at 223 µg/g, ethyl acetate extract at 90 µg/g and *n*-butanol extract at 124 µg/ml for DPPH scavenging capacity. Reducing power activity showed in crude extract at 98 mg/g, Hexane extract at 86 mg/g, ethyl acetate extract at 135 mg/g and *n*-butanol extract at 125 mg/ml. Ethyl acetate extract exhibited best DPPH scavenging assay and reducing power capacity when compared with other extracts.

Das *et al.* (2010) performed TLC analysis of *Cyathea gigantea* and *Cyathea brunoniana* with different solvent extracts. The compounds were separated by using various solvent of mobile phase such as PE-EA=9:1, 17:3, 4:1; PE-EA-M=18:1:1 and PE-EA-M=17:2:1 the more phytochemical compounds (spots) were visualised by iodine vapour. Annisa *et al.* (2020) carried out preliminary qualitative phytochemical tests using thin-layer chromatography (TLC). *Averrhoa carambola* leaves extracts (70% ethanol followed by further extraction ethyl acetate, hexane and distilled water) were used for flavonoid identification using the mobile phase chloroform: acetone: formic acid (10:2:1) and 5% AlCl₃ spray reagent, with quercetin as the positive control. TLC analysis for flavonoids showed that the ethyl acetate fraction of *A. carambola* leaves contained flavonoids, as demonstrated by yellowish fluorescent bands in the UV-visible spectrograph at 366 nm. Determining antimicrobial properties of plant extracts can be of great importance in therapeutic cure. Antibacterial susceptibility tests are used in ethnopharmacological research to evaluate the potential antibacterial activity of biological extracts against various pathogenic pathogens. By establishing the Minimum Inhibitory Concentration (MIC), these assays are used to screen plant extracts for antimicrobial properties as well as to determine the effectiveness of antimicrobial medicines in treating illnesses. *Staphylococcus aureus*, *Enterococcus faecalis* and *Klebsiella pneumoniae* was showed more antibacterial activity in *Averrhoa carambola* ethanol extract of leaf





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(Silva *et al.*, 2021). Our results showed more antimicrobial activity in *Escherichia coli* (250 µg) and *Candida albicans* (250 µg) compared with other microbes.

CONCLUSION

The current research has showed that natural sources have therapeutic properties without much toxicity. This potential of plants is due to the presence of secondary metabolites. The results prove that *Avera carambola* leaves extract has antioxidant, antibacterial and antifungal activity.

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Table1. Phytochemical analysis of aqueous extract of *Averrhoa carambola* leaves

S. No.	Contents	Aqueous extract of <i>Averrhoa carambola</i> leaves
1.	Tannins	+
2.	Saponin	+
3.	Flavonoids	+
4.	Alkaloids	+
5.	Proteins	+
6.	Steroid	-
7.	Quinones	-
8.	Terpenoid	-
9.	Cardiac glycosides	-
10.	Phenol	+

Note: (+) Positive ; (-) Negative





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Table 2. Determination of total antioxidant activity

Concentration (μg)	100	200	300	400	500
Ascorbic acid (Std) O.D	0.20	0.40	0.58	0.80	0.97
Aqueous extract O.D	0.12	0.16	0.18	0.21	0.25
Amount total antioxidant (μg)	60	80	90	110	230

Table 3. DPPH scavenging assay

BHT Concentration	100 μg	200 μg	300 μg	400 μg	500 μg
Standard O.D	0.36	0.27	0.17	0.15	0.11
% Inhibition	38.9	54.2	71.1	74.5	81.3

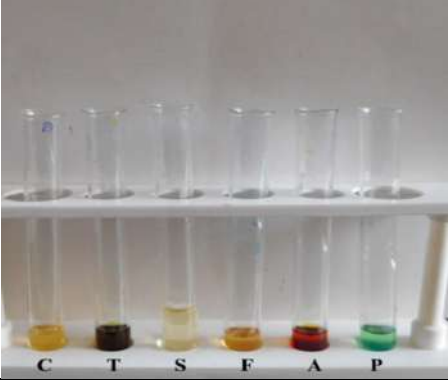
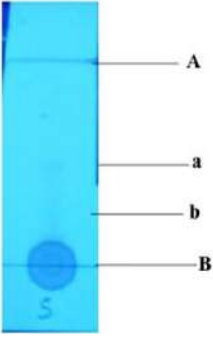
Blank - 0.59

Sample/Concentration (μg)	100 μg	200 μg	300 μg	400 μg	500 μg
Aqueous extract O.D	0.57	0.53	0.48	0.39	0.30
% Inhibition	6.5	13.1	21.3	36.0	50.8

Blank - 0.61

Table 4. The crude aqueous extract sample runs by thin layer chromatography

S. No.	Sample fractions	Distance moved by the solvent (A) (cm)	Distance moved by the solute (b) (cm)	R_f (b/A)
1	a	4.7	2.2	0.46

	
Fig 1: Cold extraction	Fig. 2. The crude aqueous extract sample runs by thin layer chromatography





The Ionospheric TEC Responses to Different Solar Flayers

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ABSTRACT

The earth's ionosphere density, temperature, and composition can alter by abrupt increases in solar irradiation during solar flare events. A study of the ionospheric variation with flare irradiance is needed to enhance the accuracy of space weather prediction and better knowledge of the photochemical process. However, a comprehensive picture of the ionospheric plasma's response to a quick solar flare explosion has yet to emerge due to the complexity or variety of flare responses recorded over time and place. In this paper, the effect of several solar flares in the ionospheric Total Electron Content (TEC) during the solar cycle's declining phase of 24 at the "nama" low latitude station of Saudi Arabia (Geog. Lat. 19.21° N, Geog. Long. 42.04° E) is investigated. For this, we have chosen the intense solar flares that come during October 2014. Our findings revealed large increases in TECU of up to 12 TECU due to the solar flare. Our findings suggest a delay in TEC response during the flares peak recovery time in a few cases.

Keywords: Ionosphere, solar flares, Total Electron Content (TEC), low latitude.

INTRODUCTION

The solar flares release magnetic energy that is converted to electromagnetic radiation with a broad spectrum of wavelengths. That can heat the material to temperatures above 10⁷ K. It produces magnetic reconnection in the solar corona. This can lead to severe problems in the form of space weather, as the radiation can reach the Earth within



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minutes and causes extreme weather conditions that are impossible to predict. The solar flare can release energies as high as 10^{25} joules, which is mainly radiation, but some of its energy is converted into accelerated and heated particles, electrons, protons, and radio bursts. The Earth's upper atmosphere temperature, density, and composition can be altered by rapid increases in solar irradiance that comes during solar flare events. That is an essential aspect of space weather research with relevance for space-based communication and navigation systems, as well as astronaut safety. (Woods and Eparvier, 2006) reported that the ratio of flare irradiance to pre flare irradiance is less than a factor of 2 in the EUV region and more than a factor of 50 in the X-ray region during large flare events. Despite the fact that the enhancement in the EUV region is substantially lower than in the X-ray region, the upper atmosphere is governed by EUV irradiance rather than X-ray irradiance. In addition, Ionosphere and thermosphere are primarily affected by solar extreme ultraviolet EUV irradiation, which is absorbed by the upper atmosphere between 90 and 200 kilometers and results in increased ionization and heating. The association between TEC enhancement and increases in EUV flux is stronger than soft X-ray flux during flares (Zhang et al 2011). Different solar transient that affects the earth atmosphere and space weather are (1) solar flares, (2) solar energetic particle (SEP) events (3) coronal mass ejections (CMEs) and their interplanetary counterparts, Interplanetary CMEs (ICMEs), and (4) stream interaction regions (SIRS) including co-rotating interaction regions (CIRs).

A solar flare can significantly increase the overall electron concentration, fadeout of short-wave, and absorption in the D region (Davies 1990; Liu et al., 2004). Zhang and Xiao (2003) used GPS TEC vales to analyze the ionospheric response to the solar flare of April 15, 2001 and found a maximum increase of 2.6 TECU for the complete sunlit hemisphere. According to Zhang and Xiao (2005), the morphological properties of SITEC increased by up to 14 TECU on the October 28, 2003, flare, which depends on the solar zenith angle at local midday. The ionosphere is affected by solar EUV radiation, and a sudden surge in EUV emission during SF can generate a severe ionization that lasts for several hours. Thus, not only from the fundamental point of view but also from the perspective of space weather applications, the study of the ionospheric response to SF is important. For many years, the impacts of SF on the ionospheric environment have been investigated (e.g., Liu et al., 2004; Zhang & Xiao, 2005; Tsurutani et al., 2009; Zhang et al., 2011; Sripathi et al., 2013). The previous studies show that the effects of SFs on the ionosphere vary with the flare type, time (day or night), and solar zenith angle. (e.g., Liu et al., 2006; Leonovich et al., 2010; Xiong et al., 2014). (Le et al. 2013) found that SFs from the disc center had a much greater impact on the ionosphere than those from the solar limb areas. (Zhang et al. 2002; Leonovich et al. 2010) Examining the TEC reaction to various SFs (C, M, and X), it was discovered that as the solar zenith angle increases, so does the increment in TEC changes.

In October 2014, a number of solar flayers events occurred, including six big X-class solar flares that triggered geophysical disturbances. Wide geographic coverage of GPS stations of the IGS network provides us a very good chance to study the global ionospheric response during solar flares. Although numerous efforts have been made, many aspects of the ionospheric response to SF are not fully understood yet. It will be necessary to conduct more research. The solar cycle 24th starts in December 2008 and maxima in 2014. The 2014 is the high solar activity period, number of solar events occurred in October 2014. In this work, we focus on the six X- class and M-classes of Solar flayers during the months of October 2014, and their impact on ionospheric effects. In comparison to solar cycles 22 and 23, solar cycle 24 has an unusually deep minimum and is diminished in terms of activity. Therefore, the study of the impact of the solar flare on the earth's ionosphere during this moderately active solar cycle may reveal novel response features not seen in previous highly active solar cycles. In this work, we use GPS TEC data over "nama" (Geog. Lat. 19.21° N, Geog. Long. 42.04° E) to examine the response of the ionosphere to X-class flares and M-class flares that occurred 19-27 October 2014 of the solar cycle 24. This article is as follows: The introduction of data and methods used in Section 2. The result and discussion are presented in section 3. Finally, the summary and conclusion are in Section 4.

DATA AND METHODS USED

A study of the solar cycle 24 maxima year 2014 is presented in this work. During October 2014, several notable flares occurred. In which six x class flare and several M and C class flayers are observed. We study all the six x



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classes, these flares at GPS stations in the low latitudes. We study TEC curves for this date considering the sunlit hemisphere and universal time so. We select “nama” IGS station which is located in Saudi Arabia and compare it with the day before and the day after at the same time zone.

X-ray data

Monitoring of solar X-ray fluxes over Earth's atmosphere has been continuous since 1975. first with the SOLRAD series satellites, and then with the GOES series satellites. For our work, we have used GOES satellite X-ray data observed in the wavelength range of 0.1 to 0.8 nm with a 1-minute resolution, which is freely accessible through the Internet at <<http://www.ngdc.noaa.gov/stp/GOES/>>.

EUV data

From 1996 to the present, daily SEM/SOHO EUV fluxes have been available. The EUV flux data retrieved from the SEM/SOHO, which monitors XUV fluxes 0.1-50 nm and EUV fluxes 26-34 nm wavelength. We used the high temporal resolution data, the 15-s average SEM/SOHO fluxes, which can be downloaded at the Website: <http://www.usc.edu/dept/space_science/semdatafolder/>

GPS derived TEC data

To investigate the TEC variation, we had considered IGS stations “nama” low latitude Station in Saudi Arabia. There have been 06 X-class flares from the same region 12192 (NOAA region) during October 2014. In addition, 4 associated M-class during the X class flares of the same region is examined.

RESULTS

We have been presented the observations of TEC changes during different SF events during October 2014. In the following section, we provide case-by-case discussions on the observed results. Figures 2, 3, 4, 5, 6, and 7 illustrate the TEC during the selected solar flares with the pink curve representing the TEC variation of solar flares event day and the blue curve representing the quiet mean of TEC computed using the VTEC of the five quietest days in October month of 2014. The difference in observed TEC value and to the quiet mean TEC (ΔTEC) is in the lower panels of figures 2, 3, 4, 5, 6, and 7. We added fluctuations in the X ray flare index (0.1-0.8 nm) and EUV flux (0.1- 50 nm) in figure 1 to better finer variation of TEC during SF events. Figure 1 depicts the variation of X-ray and EUV fluxes from October 19 to October 27, 2014. The upper panel of figure 1 shows that six intense SFs of classes X1.1, X1.6, X3.1, X1, and two X2 occurred during the period 19–27 October 2014.

Event 01: 19 October 2014

On 19 October X1.1 class SF occurrence at 0417 UT and reached maximum at 0503 UT. The variation in TEC values shown in lower panel of figure 2. During the time of occurrence the solar flare enhancement is 05 TECU at ~0503 UT on 19 October seen from figure 2. In addition, the trend of variation of EUV was the same as SF during X1.1 (Figure 1).

Event 02: 22 October 2014

On 22 October, the flares of intensity X1.6 occurred at 1402 UT. It can be seen in EUV variation that the level of the EUV flux index rapidly increased at 1428 UT, at this time local time at “nama” coincided with post-afternoon hours. The enhancement in TEC values of an order of 07 TECU observed at 1428 UT.

Event 03: 24 October 2014

On October 24, 2014, the active sunspot region AR12192 produced a strong X3.1 SF. The upper section of figure 4 shows that the X3.1 class SF occurred at 2107 UT on October 24 and strengthened at 2141 UT on the same day. By 2213 UT, the SF had decayed. As a result, this SF lasted about 1 hour. At 2141 UT, there is also a significant spike in



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the EUV index (lower section of figure 1). The lower section of figure 4 shows that the level of TEC increased at 2141 UT on October 24, with a magnitude of approximately 5 TECU.

Event 04: 25 October 2014

Figure 5 shows that the SFs of class X1 occurred on October 25, 2014. The TEC variation on October 25th showed a modest reduction in TEC at 1900 UT. As a result, the dayside negative phase prevailed on October 25, 2014. During the negative storm phase, TEC often falls below its normal value (Mendillo 2006).

Event 05: 26 October 2014

The flares occurred at 1004 UT on October 26, 2014, and the timing of occurrence of X-class flares coincided with midday hours. Our results showed a significant increase in TEC throughout the day, with the maximum increase of 11 TECU at 1240 UT. It can also be noticed that the amount of EUV decreased on October 26, 2014. (upper panel of figure 6). Previous investigations only indicated a maximum flare-induced TEC rise of up to 20 TECU (e.g., Zhang and Xiao 2003; Tsurutani et al. 2005; Hazarika et al. 2016; Yasyukevich et al. 2018).

Event 06: 27 October 2014

The SFs of class M7.1, M6.7, and X1 occurred on 27 October shown in figure 1, the TEC variation showed increased during the noon hours due to the M class SF at 0006 UT throughout the day and then a small decrement in TEC at ~ 1400 UT during the X1 SF as on 27 October was observed in figure 7.

DISCUSSION

During different SF effects, the observed TEC gets disturbed and its behavior can change during the events. Many of our examined SFs like X classes X1.1, X1.6, and X1, respectively on 19, 22, and 26 October and M class M4 and M7.1 respectively on 24 and 27 October have a significant increase in TEC of 5–12 TECU is observed these are during noontime. There is likely to be more absorption of X-ray and EUV radiation from the atmosphere neutral species (Hernandez-Pajares et al. 2012). The maximum ionization occurs below 150 km, and because the EUV component associated with SFs has higher energy, they may be able to penetrate to a depth of as little as 100 km. Chemical recombination is also relatively quick at high altitudes. The considerable TEC increase at F2 height can be interpreted as a slowing of the plasma recombination process, in which Plasma produced by photoionization at low altitudes is rapidly driven to higher altitudes where process of recombination is very slow. As a result, at altitudes more than 400 km, the electron density rises (Anthony and Bruce 2018). A minimal or no increment in electron density of the ionosphere is found for SFs that occur during the night hours, such as M8.7, X1, X2, and M4.2. The equator's noon ambient electric field is eastward, which should be noted. The vertical ExB drift of the ionospheric plasma is caused by the interaction of this field with the Earth's magnetic field, which is horizontal at the equator. And during the night, the equator's atmospheric electric field has directed the westward. The observed TEC changes took place with the greatest delay after the SF peak, such as X1.1, X1.6, X1, M4, and M7.1. The time delay in the ionosphere's response during EUV and X ray flayer variations is highly correlated to the SZA at the peak time of X ray SF (Zhang et al. 2011).

CONCLUSION

This work used total electron content TEC to investigate the electrodynamics of solar flares and their effects on the low latitude ionosphere. Our study showed enhancements in TEC at low latitude stations of the order up to 12 TECU during the chosen SF events. And the TEC enhances due to SF and the enhancement is observed maximum when SFs coincide during the noon hours. Our results also showed some delay in TEC response during maxima or recovery time of solar flares.





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Table 1 Selected X and M- class solar flare events with their start, peak, and end time.

S. No.	Date of Solar Flares	Solar Flares	Start Time (UT)	Maximum Peak Time (UT)	End Time (UT)
1.	19/10/2014	X1.1	4:17	5:03	5:48
2.	22/10/2014	X1.6	14:02	14:28	14:50
3.	24/10/2014	X3.1	21:07	21:41	22:13
4.	25/10/2014	X1	16:55	17:08	18:11
5.	26/10/2014	X2	10:04	10:56	11:18
6.	27/10/2014	X2	14:12	14:47	15:09
7.	22/10/2014	M8.7	1:16	1:59	2:28
8.	24/10/2014	M4	7:37	7:48	7:53
9.	26/10/2014	M4.2	18:07	18:15	18:20
10.	27/10/2014	M7.1	0:06	0:34	0:44
11.	27/10/2014	M6.7	9:59	10:09	10:26

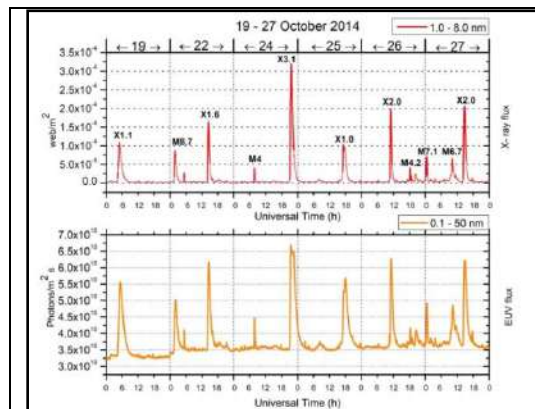


Figure 1 upper panel variation in solar X-ray flux, and lower panel EUV flux on 19–27 October 2014.

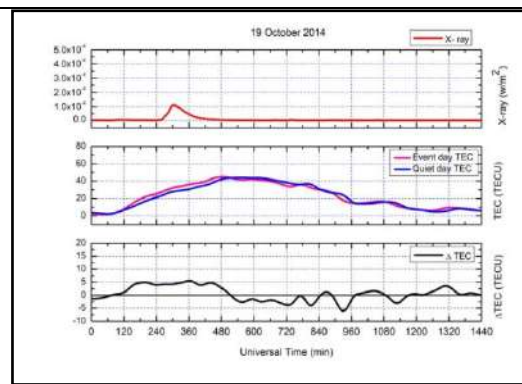


Figure 2 upper panel variation in solar X-ray flux, middle panel TEC, and lower panel difference in TEC value on the day of solar flare event to the quiet mean TEC, ΔTEC on 19 October 2014.

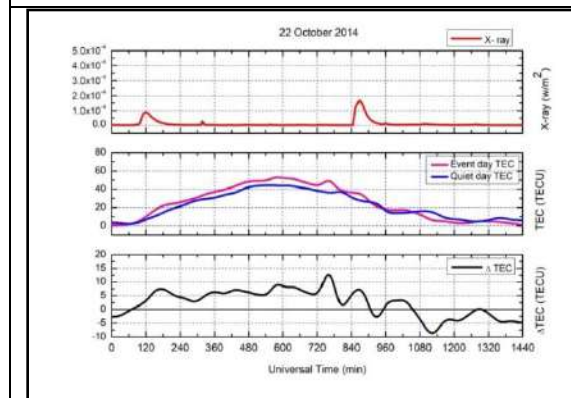


Figure 3 upper panel variation in solar X-ray flux, middle panel TEC, and lower panel difference in TEC value on the day of solar flare event to the quiet mean TEC, ΔTEC on 22 October 2014.

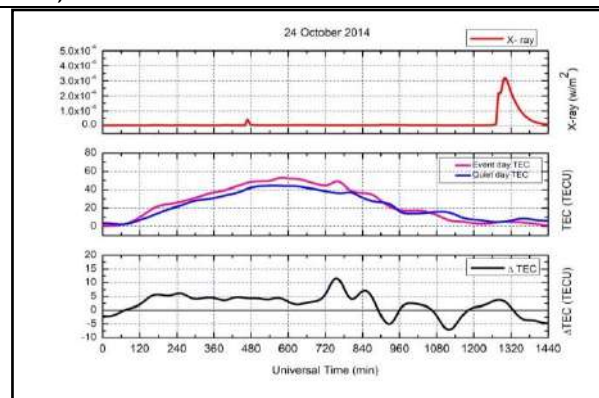


Figure 4 upper panel variation in solar X-ray flux, middle panel TEC, and lower panel difference in TEC value on the day of solar flare event to the quiet mean TEC, ΔTEC on 24 October 2014.





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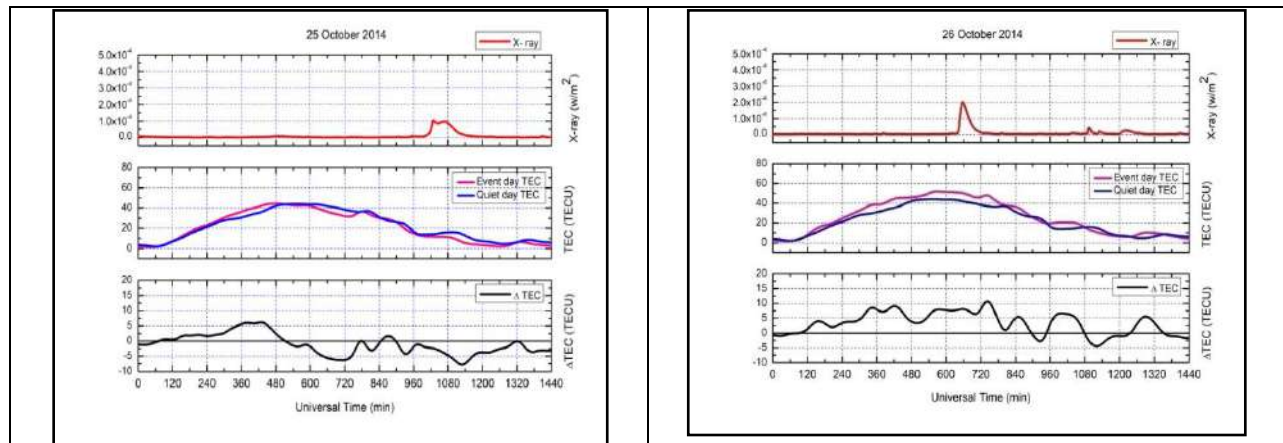


Figure 5 upper panel variation in solar X-ray flux, middle panel TEC, and lower panel difference in TEC value on the day of solar flare event to the quiet mean TEC, ΔTEC on 25 October 2014.

Figure 6 upper panel variation in solar X-ray flux, middle panel TEC, and lower panel difference in TEC value on the day of solar flare event to the quiet mean TEC, ΔTEC on 26 October 2014.

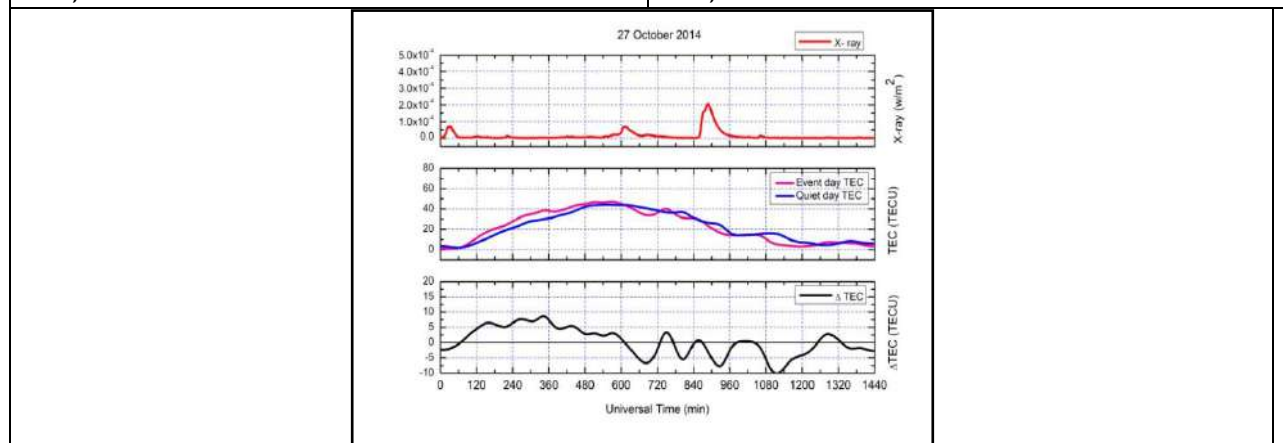


Figure 7, upper panel variation in solar X-ray flux, middle panel TEC, and lower panel difference in TEC value on the day of solar flare event to the quiet mean TEC, ΔTEC on 27 October 2014.





Smart Wildlife Vehicle Collision Detection System

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ABSTRACT

Animals are an important part of the wildlife and forests. But humans are a major cause of the damage caused to the wildlife. Damage caused by vehicles to animals is an important cause for this. Reckless driving of humans and the trespassing of animals on roads are a major cause of human made deaths to animals. The accidents due to Wildlife Vehicle Collision (WVC) contribute a significant proportion to the number of accidents happening around the world. Usually, the death of these animals goes unnoticed and removal of the dead bodies of the animals is not carried out. The individuals responsible for these accidents are also not caught. Hence this system aims at providing a solution to alert the driver about animal crossing and facilitating the removal of the dead bodies of the animals by the forest department if an accident has occurred. At times when the animal is injured, an immediate call for emergency is given to the Forest Department. The Forest department can make the necessary arrangements to save the animal. The detail of the colliding vehicle is captured with the help of cameras and the images are provided to the Police Department. With the help of our technology, we facilitate the ease of transportation and also save the animals, eventually saving money for the Government. The WVC detection system uses PIR and Ultrasonic sensors, web cameras along with the Raspberry Pi kit to facilitate the detection.

Keywords: Raspberry Pi, Sensors, Collision Detection, OpenCV, Information transfer.





INTRODUCTION

Wildlife-Vehicle Collisions (WVCs) are a global problem that impacts both wildlife and motorists and are a growing concern among Departments of Transportation (DOT), conservation organizations and agencies, and the driving public. It is also a safety concern for drivers and a conservation concern for most animal species. WVC occurs when a vehicle hits an animal as it tries to cross the road [1,2] or when humans interfere in certain animal hotspots. The consequences are profound and include significant socio-economic, traffic safety and environmental costs and concerns. Animal-vehicle collision is a challenging problem for cars, especially in certain rural areas or hill stations where animals are in their natural habitat. It is reported that in the United States, more than 90 percent of animal-vehicle collisions involve large animals such as deer or moose [3], with the total number of two million collisions per year [4,5]. Such animal-vehicle collisions cause about 200 human deaths, 29,000 injuries, and 1.1 billion dollars in property damage every year. WVCs not only result in death and serious injuries, but certain species that belong to an area are becoming endangered and are at risk of disappearing from their natural habitat or even become extinct, which is a threat to biodiversity in our country. The sheer number of animals that are killed in vehicle-collisions [4,6] is alarming. Wildlife-vehicle collisions involving large species can cause substantial vehicle damage and human injuries and are a key public safety concern[7,8]. Reckless driving of humans and the trespassing of animals on roads are the major cause of human made deaths to animals. We cannot blame the animals for these WVCs as it is because of the humans, who build roads in the villages and forests. As these accidents are on the rise, there is a need to try to prevent and detect these accidents [9] so as to reduce the number of accidents and possibly save the lives of both the animal and the human involved in the collision. A complete analysis of the WVC hotspots is needed to reduce the conflict. There have been many measures taken by the government to reduce these accidents but they have not ensured a significant reduction in these collisions. The Smart Wildlife Vehicle Collision Detection System aims to reduce the frequency of wildlife-vehicle collisions.

LITERATURE REVIEW

The governments of various countries have identified Wildlife Vehicle Collisions as a major threat to human and animal life and have hence introduced many methods to try and reduce them. There have been a variety of static and dynamic methods to decrease the number of collisions. The static methods include sign boards, fences [4] and special animal movement corridors. Specific sign boards are installed at animal vehicle collision hotspots to warn the riders about the possibility of an undesirable event. These sign boards don't provide real-time animal information and hence does not reduce the number of accidents significantly[10]. Fences have been installed at various places to restrict the movement of animals and prevent them coming onto the road. Fences are one of the most commonly used methods of preventing WVCs and is also the most cost effective one [11]. The major drawback of this method is that physically stronger animals such as elephants and ungulates could easily break down these fences and roam around on roads. In certain economically forward countries, special corridors [12] have been built across roads to aid the movement of animals from one side of the road to another. Though corridors provide the best way for better movement of animals, they prove to be quite expensive. Hence there is a need for cost effective and scalable systems to detect the animals and possibly try to prevent WVCs. Many technologies have also been developed as a result of this to reduce the number of collisions. The technologies can be mainly classified into two categories: Roadside and Onboard systems. Roadside systems are installed at the sides of the roads to detect possible animal crossings and the driver is notified when there is a crossing. Onboard systems are installed on vehicles such as cars to warn the drivers when the animal is detected. All these methods use a camera to take pictures and the pictures are analysed to find out animal movement. These methods, though able to detect the movement of animals accurately, doesn't provide a mechanism to identify animal collisions and send alerts to the respective department.





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METHODOLOGY

There is a need for the immediate and rapid transfer of information [13] regarding the accident to the necessary authorities to provide first aid to the injured. Thus we have proposed the Smart Wildlife Vehicle Collision Detection System to facilitate information transfer as explained in Figure 1. This system is built as a roadside system where all the components are fixed at the side of the road. The camera monitors the road and a Python program detects the collision. In such a case, the information regarding the accident is sent to the Police department and the Forest Department. The Police department then scrutinizes the available information for further investigation. The Forest department sends an ambulance for the wounded animal(s) and human(s). All the required information is transmitted instantaneously and this is the major advantage of this system.

HARDWARE AND SOFTWARE REQUIREMENTS

The system requires the combination of various sensors, processors and softwares for its working. The major requirements that are essential for the system are listed below.

PIR Sensor

The PIR sensor is a special material which is sensitive to IR and it has two slots. When the sensor is idle, both slots detect the same amount of IR radiated from the walls or outdoors. When a warm body (human or animal) passes by, one half of the PIR sensor is intercepted first which results in a positive differential change between both the slots. Once the warm body leaves the surroundings the reverse happens, that is the sensor results in a negative differential change between the two slots. These changes in pulses are detected by the sensor.

Ultrasonic Sensor

An ultrasonic sensor consists of a transmitter and a receiver. When an obstacle is detected it generates and receives the ultrasonic waves. The HC-SR04 Ultrasonic Module has 4 pins, Ground, VCC, Trig and Echo. To generate the ultrasound, we need to set the Trig on a High State for 10 microseconds which will send out an 8 cycle sonic burst. It will travel at the speed of sound and it will be received in the Echo pin which will output the time in microsecond that the sound waves travelled. When any object comes within the range of the sensor, the ultrasonic sensor will produce an output. Ultrasonic sensor along with the PIR sensor is used to detect animal motion [14,15].

LCD Screen

LCDs are super-thin technology display screens that use a liquid crystal to produce a visible image. Liquid crystal display consists of several layers which include two polarized panel filters and electrodes. The combination of coloured light with the grayscale image of the crystal (formed as electric current flows through the crystal) forms the coloured image. This image is then displayed on the screen.

Raspberry Pi

The Raspberry Pi [16] is a small sized computer which is developed by Raspberry Pi foundation. We use a Raspberry Pi 3 Model B. The Raspberry Pi 3 Model B is the earliest model of the third-generation Raspberry Pi. It includes a Quad Core 1.2GHz Broadcom BCM2837 64bit CPU, 1GB RAM, Bluetooth 4.1, 802.11.b/g/n Wireless LAN, 40-pin extended GPIO, 4 USB 2 ports, full size HDMI among various other features. An upgraded switching micro USB power source upto 2.5A is present in this model. The operating system Noobs boots from the MicroSD card inserted in the Pi. The Raspberry Pi contains the code for analysing the scene.

Web Camera

The web camera [17] is used to capture the images of the road. The web camera has a resolution of 640 x 480 and uses an 8mm lens. The encoding is in MPEG format and the digital signal system is used. The camera has IR capabilities



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to capture images during the night. It has a night vision range from 5 – 30 metres. The camera is easy to plug in through a USB and is supported by Raspberry Pi.

OpenCV

OpenCV is an open source computer vision library that is used with the Python Programming Language. It is mainly aimed at real-time computer vision. The library has more than 2500 optimized codes that can be used for various activities such as recognizing faces, identifying objects, track camera movements, find similar images and so on. We will be using the OpenCV library to extract the number plate from the accident scene and also to detect the animal vehicle collision [16]. The existing Open CV algorithms are used for this purpose.

Keras

tf.keras is Tensor Flow's high-level API for building and training deep learning models. It's used for fast prototyping, state-of-the-art research, and production, with three key advantages: User-friendly, Modular and composable, Easy to extend. Keras has a simple, consistent interface optimized for common use cases. It provides clear and actionable feedback for user errors. Keras models are made by connecting configurable building blocks together, with few restrictions. It is possible to write custom building blocks to express new ideas for research. We can create new layers, metrics, loss functions, and develop state-of-the-art models.

EXPERIMENTAL SETUP

The experimental setup of the components is explained in this chapter. Two types of sensors: Ultrasonic Sensor and the PIR Sensor are installed on the sides of the road to detect for possible animal movement. If any such movement is sensed by the sensors, a warning message is shown on the LCD Screen by the Raspberry Pi to which the camera is connected. The connection between the various components of the setup is shown in Figure 2. The camera is turned on to detect possible animal vehicle collisions [18, 19]. The Raspberry Pi is used as the storehouse and the processor. After obtaining the signal from the sensors, the Raspberry Pi turns on the camera and takes pictures of the road for possible accidents. The images are stored in an SD card located in the camera. The accidents are detected using a python program which uses machine learning techniques to detect if there is an accident in the image that is given as the input [20]. Once the accident is detected [21], the photo of the number plate of the vehicle is captured, the place and time of the accident is sent to the Police and Forest departments via an email.

METHODOLOGY

The basic structure of this system consists of PIR and Echo sensors which are attached to the Raspberry Pi. The PIR and Ultrasonic sensors detect the motion of the animals near the road sides. When movement is received, the Raspberry Pi alerts the drivers within a particular radius of possible animal crossings by displaying a message on the LCD.

Sensing the Movement

The following Algorithm does the sensing part in the Raspberry Pi.

1. Compute the distance between the object and sensor for every one second using Echo sensor.
2. $\text{Distance} = \text{Speed} \times \text{Time}$
3. $\text{Real Distance} = \text{Distance}/2$
4. Set the Dout pin of the PIR sensor as input pin(p) and measure the value as $\text{val} = \text{digital Read}(p)$
5. Get val and Real Distance.
6. If ($\text{val} = \text{HIGH}$ and $\text{Real Distance} \leq \text{required-distance}$), Display "Animal Crossing" in LCD and go to the next step.
7. Else Display "Safe Journey" in LCD and go to the previous step.



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If motion is detected, the Raspberry Pi initiates the webcam. The webcam starts capturing images. These images are used for accident detection purposes. The accidents are detected using a Deep learning model which runs in the Raspberry Pi.

Detecting the Accident

The camera is started whenever a motion is detected. The dataset consists of two classes, namely "Accident" and "No Accident". It consists of images collected from Google Images. The image data generator function in keras preprocessing library is used to link the dataset to the model. The build function of the model is used to build the model with reference to the dataset. The model is compiled for errors and is trained for 10 Epochs. Once an accuracy threshold of 0.9 is obtained, the model is saved for deployment. The predict function of TensorFlow is used to give an image to the model as the input and check if the image has an accident scene or not. The image is classified into one among the two classes. If the image has an accident scene, it is sent to the number plate detection algorithm to extract the number plate.

Extracting the Number Plate

The recordings are stored as images. When an accident is detected [22], the images are processed to detect the Number plate of the vehicle and the processed images are sent to the Police Department. The Number plate of the vehicle involved in the accident is detected by the Number plate tracking algorithm [23]:

1. The original image is converted into a Grayscale image for easier extraction.
2. All the possible characters in the scene are found out using the K-Nearest Neighbours algorithm and a vector of all the possible characters is generated.
3. Using the vector of possible characters, a vector of all the possible plates is generated.
4. Each and every plate in the vector is converted to grayscale and all the possible characters in the plate is generated. This set of characters in a plate is analysed.
5. Within each possible plate, the longest list of characters is considered to be the actual number plate.
6. The number plate is finally bounded and an image is generated.

Sending the mail

This number plate image, along with the accident image is then transferred to the Police Department. The location of the accident and the accident image is sent to the Forest Department. This information is sent with the help of an automated Email [12]. The email can be made to send once all the required information is gathered. This mail is sent to the departments with the help of SMTP [24] Gmail Server. After the information transmission, the whole process starts from the beginning, waiting for an animal's movement to extraction of the number plate from the scene. The overall flow of the system is shown in Figure 3.

PERFORMANCE ANALYSIS

There isn't any mechanism to detect Wildlife vehicle collisions spontaneously. In this paper, a Raspberry Pi based system to detect collisions and send the information instantaneously is devised. The detection here is done with the help of a camera connected to the Raspberry Pi. It is assumed that the surroundings are captured by placing the camera at a tree/pole so that it is able to get a 180° view. The sensors are placed at the tree/pole facing each other with the assumption that the animal would reach the road by crossing the pole. In the proposed work, the deep learning model is run to detect for possible accidents. The model used is a Sequential model. Sequential model is a linear stack of layers. The model consists of three Convolutional layers and two Dense layers of 128 and 1 parameters each. One of the dense layers is used for binary classification at the end of the Neural Network. A Flatten Layer is used between the convolutional and dense layer to flatten the inputs. A Dropout of 0.5 is used. It helps in reducing over fitting by randomly turning off 50% of neurons while training. ReLU and softmax activations are used. Soft max is used for the



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last dense layer while all the other layers use ReLU activation. The model is compiled using 'adam' optimizer. An accuracy threshold of 0.9 is accepted as the limit for the model. The Summary of the model is given in Figure 4. The number plate detection algorithm attempts to capture the number plate of the vehicle from the accident scene. This number plate detection system is able to detect if there is any number plate from the image provided. This algorithm takes an average of 600ms to produce the output number plate for an input accident scene image. An already existing number plate detection system is used in our system. After the number plate is extracted, it is sent to the respective departments with the help of an email using the Gmail SMTP server. The program to send a mail to the departments takes a few seconds to reach the inbox of the departments if the Raspberry Pi is connected to the internet. Faster internet connectivity could reduce the time taken in sending the mail after the program gets executed. Though there may be some delay in the arrival of necessary help, the proposed system is still faster and more efficient than others of its kind. Various images of varying quality, file size, file resolution, zoomage have been taken and given as an input for the number plate detection algorithm.

The time taken for the execution of the program is noted and various observations were made. Three important parameters, time taken to process the image in milliseconds, size of the file and the quality of the image, are compared and a scatter plot as shown in Figure 5 is created to analyse the difference in the running times between different kinds of images. The quality of the images could be categorised into High, Medium and Low quality based on their level of pixelation. It could not be clearly interpreted that low size equals faster time execution. Images that are pixelated take longer to execute than normal images whereas as usual, images with larger image size and high quality take longer to execute. This distribution is random and the fastest runtime is achieved by taking a clear image with a considerable image size of 20KB-50KB. The accuracy of the number plate detection algorithm varies with file quality and zoomage. A graph with respect to the quality of the image as shown in Figure 6 is presented. It could be perceived that images with higher qualities lead to more accurate detection whereas images with low qualities lead to poor detection of the number plate. Thus the camera that is set up with the Raspberry Pi should yield images of comparatively high clarity for the algorithm to detect the number plate successfully. The number plate detection algorithm is not based on any dataset and hence repeated training of the algorithm will not improve the accuracy rate. Machine learning models could be used to detect number plates from the image in the future. The accuracy varies with respect to the zoomage of the number plate in the image. For different qualities of the image, the accuracy rate vs the zoomage is compared and visualised in the form of a chart.

RESULTS

Whenever a movement is sensed by the PIR and Ultrasonic sensors, the message "Animals" is displayed on the LCD Display and Accident Detection algorithm is started. The message "Safe Journey" is displayed until any movement is sensed with the sensors constantly sensing for any possible movements as seen in Figure 8. When an accident occurs, it is detected and the Number plate detection algorithm is started, the output of which is shown in Figure 9. If there is no accident, the accident detection algorithm constantly runs for a particular amount of time. After that, the process starts from the beginning. If a number plate is detected by the number plate detection algorithm, the number plate image is mailed to the Police Department. Else, if no number plate is detected, no mail is sent. These are the possible results that can occur and can be observed in the number plate detection algorithm. After the number plate is extracted, it is sent as a mail to the Respective Departments as shown in Figure 10. cases when noise is present, we may be able to get away with noise removal techniques used in the implementation, though the accuracy will depend on there maining data that we have after the noisy part is removed.

SCOPE FOR FUTURE WORK

This implementation of the Wildlife Vehicle Collisions(WVC) detection system is just a prototype of its kind. There is room for improvement in the way it is implemented. The data here is stored and processed locally in the Raspberry Pi, which is not backed up and is prone to data loss. Cloud concepts can be used to perform storage and processing



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of the necessary images. The images taken from the various webcams can be stored in an Amazon S3 storage bucket [25] and these images can be processed by storing the necessary codes in an Amazon EC2 instance. The processed images can then be sent to the respective departments from the EC2 instance. The power to be given to the Arduino and Raspberry Pi should be either via a battery or an AC source. It is difficult to find an AC source in the remote areas and the frequent replacement of batteries is a major issue if we use them. Hence, a solar powered power source could be used to supply power to the boards in the remote areas. Alternatively, a step-down transformer can be used to extract power from the supply lines that pass through the area. The system uses images to detect the accidents and there may be cases where there has been a minor collision and the animal isn't hurt. The accuracy of the system could be improved by using Audio Analysis [26] programs to detect if the animal is in pain or not by analysing its cry. This will avoid the need for help at times when it isn't needed.

CONCLUSION

Wildlife Vehicle Collisions are on the rise and pose a major threat to the vehicles and the animals. There are many ways to prevent and detect such accidents but none of them were able to rapidly transfer information to the concerned organisation. There were only static methods for preventing accidents but not any dynamic ones. Fitting cameras in cars to detect accidents does not leave the riders with time to react. Even if a system is successful in detecting an accident, it doesn't provide any means of helping the injured. Hence a WVC detection system is introduced in this paper which aims at detecting the accidents and immediately notifying the Forest department about the accident so that first aid could be provided for the injured. Such a system will be helpful in saving the lives of the injured. By fitting cameras at trees, we could alert the drivers of animal crossings beforehand. This system could be used in remote areas where there is very little human settlement. Thus the system provides a cost-effective, technology based approach of detecting accidents on the road.

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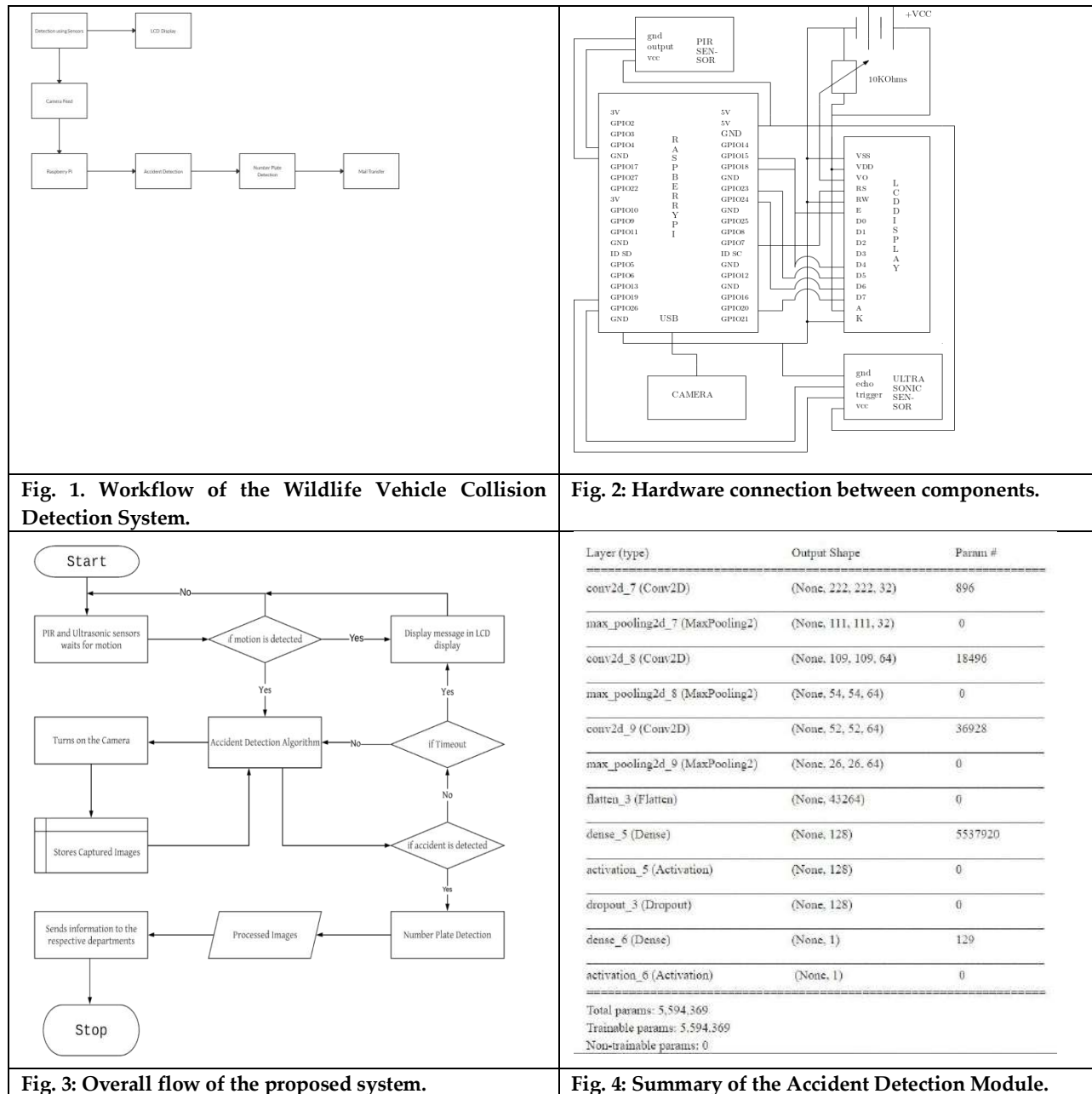
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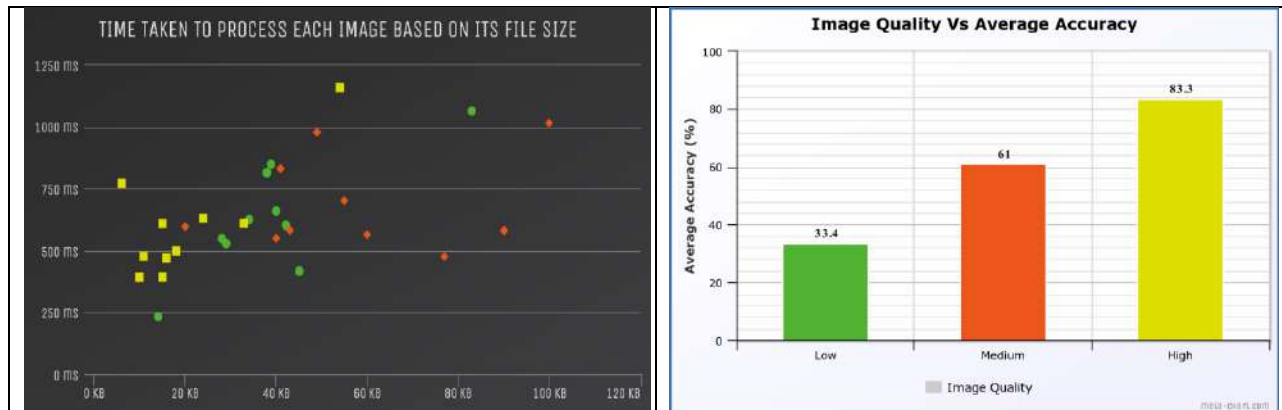


Fig. 5: The scatter plot showing the relation between the size of the file, quality of the image and the time taken to process the image.

Fig. 6: A bar graph showing the relation between the image quality and accuracy.

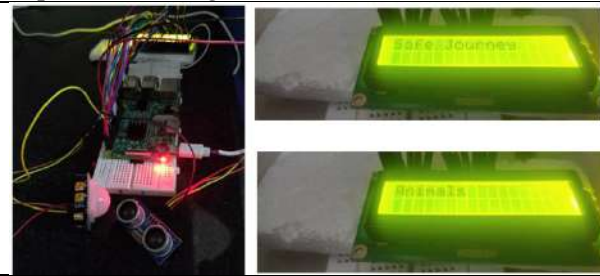


Fig. 7: Output of the sensing module.



Fig. 8: The number plates from the scene extracted using the number plate detection algorithm with its output.

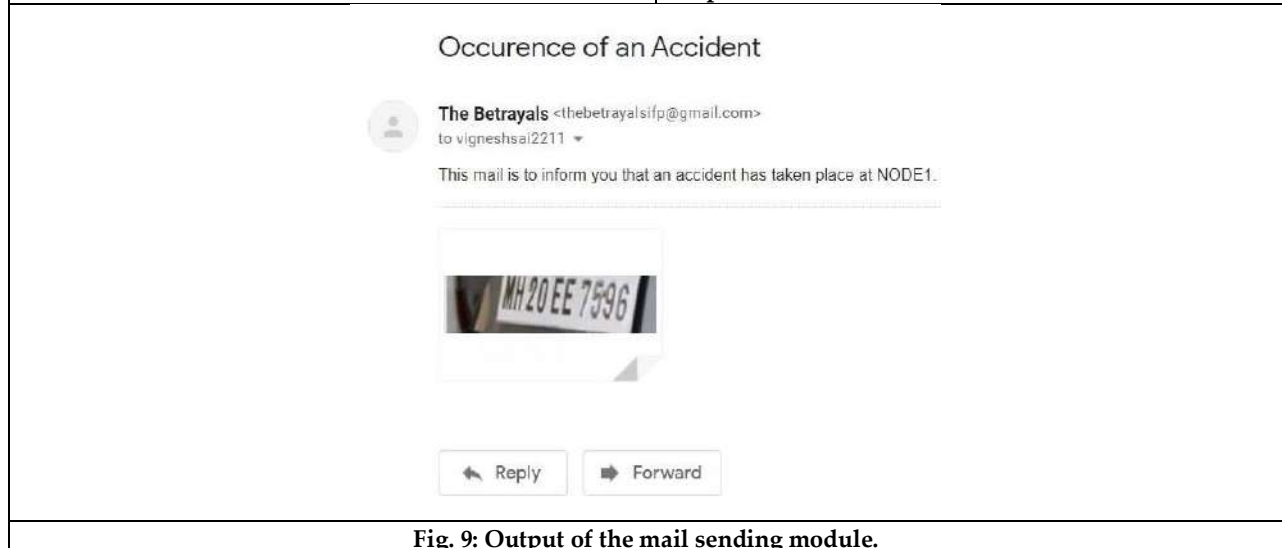


Fig. 9: Output of the mail sending module.





Qualitative and Quantitative Analysis of *Thurunji Manapaagu* – A Siddha Herbal Formulation

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ABSTRACT

Citrus aurantium belongs to the family Rutaceae and possesses multiple therapeutic potential. It is known for its antimicrobial, anti-cholinesterase, antispasmodic, anticoagulant, radical scavenging, and anti-cancer activities. In this paper, an attempt was made to evaluate the Siddha herbal medicine *Thurunji Manapaagu* by analytical methods and chromatographic studies. It is a compound with fruit juice *Thurunji* (*Citrus aurantium*) and sugar (*Saccharum officinarum*). It is indicated for reducing the vitiated *pithathodam* and other *pitham-related* disorders. *Manapaagu* (syrup) is one of the easily palatable dosage forms with a shelf life of 6 months. *Thurunji Manapaagu* is a mild yellowish, free-flowing, non-greasy, non-viscous liquid with an acidic pH of 5.1 and a specific gravity of 1.088. It is soluble in water, ethanol, and DMSO and insoluble in chloroform, ethyl acetate, and hexane. It is a clear solution with no visible foreign particles. The preliminary phytochemical analysis revealed the presence of carbohydrates, saponins, flavonoids, diterpenes, gum, and mucilage which supports the literature study of the individual ingredients of the drug. TLC profiling of the sample confirms the presence of phytochemicals. HPTLC fingerprinting analysis reveals the presence of six prominent peaks corresponding to the presence of six versatile phytocomponents present with the R_f ranging from 0.02 to 0.90.

Keywords: *Citrus aurantium*, chromatographic studies, phytochemical analysis.

INTRODUCTION

Siddha is one of the ancient medical systems in India considered the mother medicine of ancient Tamils/ Dravidians in south India. The word Siddha means established truth. The Siddha system of medicine was classified based on five properties *svavai*(taste), *gunam*(character), *veeriyam*(potency), *pirivu*(class), and *mahimai*(action) [1]. It is based on the concept of “*Annada thilullathaepindam, pindat hilullathaeandam*” which means the composition and life of the human body are like the composition of the universe e.g., Extrinsic, and Intrinsic factors in health and disease[2].



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The World Health Organization (WHO) defines herbal medicine as a practice that includes herbs, herbal materials, herbal preparations, and finished products that contain active ingredients parts of plants or other plant materials. The active ingredients protect plants from damage and diseases and contribute to the plant's aroma, flavor, and color. Scientifically, they are known as phytochemicals [3].

Chromatographic methods are an excellent tool in the analysis of bioactive compounds present in pharmaceutical preparations and extracted from the plant medicinal substance. The versatility and resolving power of chromatographic systems have made chromatography an excellent analytical technique intensively used for scientific, industrial, and medical purposes [4]. Thin-layer chromatography is the preliminary step to identify the phytochemical constituents in a sample. High-performance thin-layer chromatography HPTLC can provide an electronic image of the chromatographic fingerprint and a densitogram to detect the presence of a marker compound in a plant sample. It is the most efficient, faster, reliable, and reproducible [5]. In this paper, an attempt was made to evaluate a Siddha formulation, *Thurunji Manapaagu* by analytical methods and chromatographic studies. *Thurunji Manapaagu* is used to treat *Pithathodam* and diseases preceding the *Pithathodam*. *Manapaagu* (syrup) is one of the easily palatable dosage forms with a shelf life of 6 months.

MATERIALS AND METHODS**Preparation of trial drug *Thurunji Manapaagu***

Thurunji Manapaagu was prepared as per the Siddha classical literature, *Siddha Vaidhiya Thirattu*. Ref. K.N. Kuppusamy Mudhaliyaar, 1st edition, published by the Directorate of Indian Medicine and Homeopathy (1933).

Ingredients

Thurunji fruit juice - *Citrus aurantium*
Sugar - *Saccharum officinarum*

Procurement and authentication of the drug

The fresh fruit was procured from Accharapakam farmlands, and it was authenticated by the botanist of the National Institute of Siddha.

Preparation of the Drug

The fruit juice was taken in an earthen pot. Sugar crystals are added and boiled until moisture content evaporates and an aromatic odor appears. The *Manapaagu* formed was stored in an airtight container. Represented in Figure – 1.

Analytical Methods [6]

The analytical methodology includes the determination of organoleptic characters, solubility, physiochemical parameters, preliminary Phytochemical analysis, TLC photo documentation, and HPTLC fingerprint studies.

Organoleptic Characters

The Organoleptic characteristics such as color, odor, taste, flow property, nature, and consistency were noted.

Solubility

The solubility of *Thurunji Manapaagu* was noted in different solvents.

Physiochemical Parameters

The physio-chemical examination includes specific gravity, pH, and clarity of the *Thurunji Manapaagu* was determined by standard methods.

Preliminary Phytochemical Analysis

Preliminary Phytochemical analysis for phenols, terpenoids, steroids, flavonoids, quinines, coumarins, alkaloids, tannins, acids, and glycosides were conducted by standard procedures.

Thin Layer Chromatography

The sample was subjected to a thin layer chromatography method using silica gel 60F254 cm (Merck). The mobile phase which was used Chloroform: n-Butanol: Methanol: Water: Acetic acid (4:1:1:0.5:0.5). Micropipettes were used to



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spot the sample for TLC and applied sample volume of 10- microliter by using pipettes at 1 cm at 5 tracks. In the twin chamber with the specified solvent system. After the run plates were dried and were observed using visible light short-wave UV light 254nm and light long-wave UV 365nm [7].

HPTLC Finger Print**Chromatogram Development**

It was conducted in CAMAG Twin Trough chambers. Sample elution was carried out according to the adsorption capability of the component to be analyzed. After elution, plates were taken out of the chamber and dried. Plates were scanned under UV at 366nm. The data obtained from scanning were brought into integration through CAMAG software. The chromatographic fingerprint was developed for the detection of phytoconstituents present in each sample and their respective R_f values were tabulated [8].

RESULTS:**Organoleptic characteristics:**

The organoleptic characteristics of *Thurunji Manapaagu* are shown in Table 1, *Thurunji Manapaagu* was a mild yellowish, non-viscous, non-greasy, free flowing with a characteristic odor.

Solubility

The solubility of *Thurunji Manapaagu* is shown in Table 2. *Thurunji Manapaagu* was soluble in water, ethanol, and DMSO.

Physiochemical analysis

Physiochemical analyses of *ThurunjiManapaagu* are shown in Table 3. It is a clear solution with a specific gravity of 1.088 and pH 5.1.

Phytochemical analysis

The preliminary phytochemical analysis of *Thurunji Manapaagu* is shown in Table 4. *ThurunjiManapaagu* contains carbohydrates, saponins, flavonoids, diterpenes, reducing sugars, gum, and mucilage.

TLC and HPTLC fingerprint

The TLC photo documentation and HPTLC fingerprinting are shown in Figures 2 and 3. The fingerprint documentation reveals the presence of six volatile phytoconstituents.

DISCUSSION

Thurunji Manapaagu is a Siddha herbal preparation consisting of the fruit juice *Thurunji(Citrusauranium)* and *Sarkari (Saccharum officinarum)* which is used to treat the *pithathodam* and the disease related to vitiated pitham. As per Siddha literature, “*pithamathikaripinpesumparikaramsuthaththuvarodussolliniupusathaagum*” by *Kannusamiyam* states that the increased *pithamthodam* is pacified by the taste of bitter, sweet, and astringent. The plant *Thurunji* is known as *kittchilipalam*, *kolunjipalam*, possesses the taste of bitter and sweet. The *Citrus aurantium* fruit possesses proton radical, oxyradical, and hydroxyl radical scavenging abilities. Regression analysis showed a positive association between total phenolics and different antioxidant assays [9]. *Sarkari (Saccharum officinarum)* has the taste of sweet and coolant properties. “*Senkarumbupathana saarutheerthidumpithamellam*” The quote states that the juice indicated for the reduction of *pithamthodam*. It has been used as an adjuvant for various Siddha medicines [10].

Thurunji Manapaagu is a mild yellowish, free-flowing, non-greasy, non-viscous liquid with an acidic pH of 5.1 and a specific gravity of 1.088. It is soluble in water, ethanol, and DMSO and insoluble in chloroform, ethyl acetate, and hexane. It is a clear solution with no visible foreign particles. The preliminary phytochemical analysis revealed the presence of carbohydrates, saponins, flavonoids, diterpenes, gum, and mucilage which supports the literature study of the individual ingredients of the drug. Saponin has been reported to have a wide range of pharmacological and medicinal activities. It has been revealed that saponin has both hypertensive and cardiac depressant properties. They are potentially useful for the treatment of hypercholesterolemia which suggests that saponin might be acting by interfering with intestinal absorption of cholesterol, thus having antidiabetic effects [11]. The flavonoids of citrus fruits include Quercetin, myricetin, rutin, tangerine, naringin, and hesperid in which possess antioxidant activity



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[12]. HPTLC fingerprinting analysis of *Thurunji Manapaagu* reveals the presence of six prominent peaks corresponding to the presence of six versatile Phytoconstituents presenting R_f values 0.02, 0.09, 0.12, 0.18, 0.21, and 0.90. The HPTLC results are interpreted based on the area coverage of the peak, the height of the peak, the number of peaks, and the R_f value of the peaks. It was noted that the six components occupied the R_f value ranging from 0.02 to 0.90. Among them, peaks 0.02 and 0.90 have higher percentage areas of about 43.44% and 20.35% which denotes the abundant existence of this compound. The prior studies of HPTLC fingerprint of *Citrus aurantium* rind scanned at wavelength 254nm for ethanol extract revealed eight polyvalent phytoconstituents with R_f values ranging from 0.03 to 0.80 in which the highest concentration was found to be 48.61% and its corresponding R_f value was found to be 0.03 [13]. Herbal medicines are composed of many phytoconstituents. It is important to obtain reliable chromatographic fingerprints that represent pharmacologically active and chemically characteristic components. HPTLC fingerprinting profile helps for the herbal drug standardization with proper identification of medicinal plants. These methods were also employed to analyze commercial samples to illustrate their application in qualitative and quantitative determinations, demonstrating their feasibility in the quality control of Phytoconstituents from herbal drugs and formulations [14].

CONCLUSION

Analysis of *Thurunji Manapaagu* has been carried out to put forward the standards for evaluating its quality and purity. The present study has revealed the physiochemical, preliminary phytoconstituents, TLC, and HPTLC fingerprinting of the drug. However, in addition to the present study, further clinical and preclinical studies are mandatory to confirm the efficacy of *Thurunji Manapaagu* for *pitham-related* diseases. This study can be a beneficial root of data for future research.

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Table 1 : Organoleptic characters of *Thurunji Manapaagu*

State	Liquid
Nature	Non – viscous
Odor	Characteristic
Touch/Consistency	Non- Greasy
Flow property	Free Flowing
Appearance	Mild Yellowish

Table 2 : Solubility Profile of *Thurunji Manapaagu*

S. No	Solvent used	Solubility/Dispersibility
1	Chloroform	Insoluble
2	Ethanol	Soluble
3	Water	Soluble
4	Ethyl acetate	Insoluble
5	Hexane	Insoluble
6	DMSO	Soluble

Table 3 : Physiochemical analysis of *Thurunjimanapaagu*

S.no	Parameters	Results
1	pH	5.1
2	Specific gravity	1.088
3	Clarity	Clear solution with no visible particles

Table 4 : Phytochemical analysis of plant *Thurunji* and *Thurunji Manapaagu*

S.no	Phytochemicals	<i>Thurunji Manapaagu</i>
1	Alkaloids	-ve
2	Carbohydrates	+ve
3	Saponin	+ve
4	Phenols	-ve
5	Tannins	-ve
6	Flavonoids	+ve
7	Diterpenes	+ve
8	Quinines	-ve
9	Gum and Mucilage	+ve
10	Reducing sugars	+ve

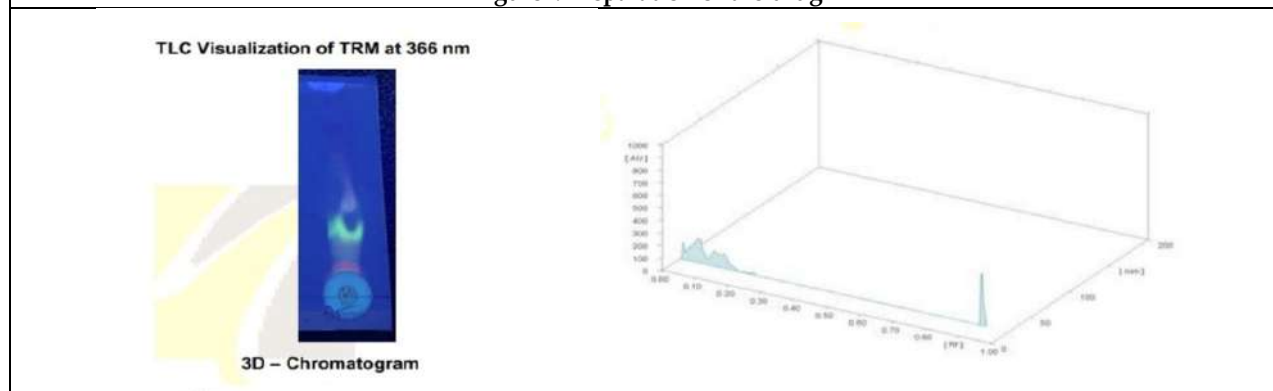
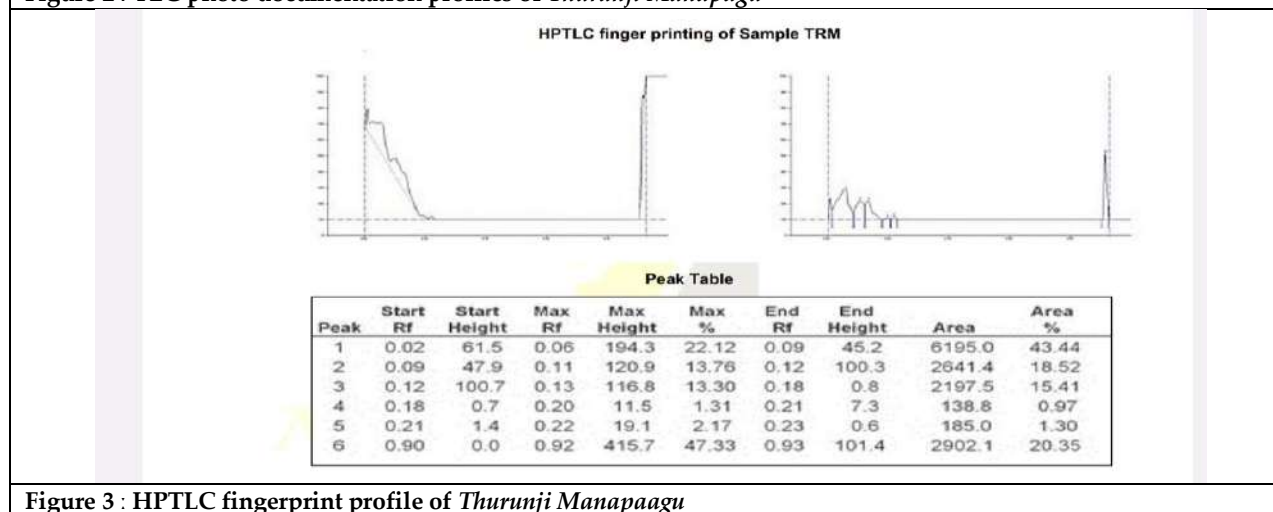




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Figure1: Preparation of the drug

Figure 2 : TLC photo documentation profiles of *Thurunji Manapagu*Figure 3 : HPTLC fingerprint profile of *Thurunji Manapagu*



Comparison of Mirror Box Therapy, Action Observation Technique and Motor Imaginary Technique in Stroke Patients - A Narrative Review

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ABSTRACT

In stroke there is a sudden interruption of the blood flow to the brain which leads to severe motor and sensory dysfunction. In this 80% have motor impairment among them 20% recovered in a few months while the remaining 50-60% are left with the chronic motor disorder and approximately 50% of stroke patient's show somatosensory deficits. The aim of the study is to review the literature on effectiveness of various cognitive Therapy i.e, Mirror box therapy, Action observation technique, and Motor imaginary technique in stroke patients. Electronic databases used for relevant trials: were Google scholar, PubMed, Cochrane and NCBI. All the articles, irrespective year of publication, on Mirror box therapy, Action observation technique, and Motor imagery technique in stroke patients were kept as Inclusion Criteria. Total 192 articles were search which includes Mirror box therapy, Action observation technique, and Motor imaginary technique in stroke patients. After screening 41 studies were finally included in the review. A total of 41 studies were finally included in the review. 14 studies of the Action observation Technique, 12 studies of Mirror box therapy, and 14 studies of Motor Imagery technique. All three methods significantly improved motor & sensory dysfunction in stroke patients. The effectiveness of each technique varied depending on the stage of the stroke; MBT improved hand function in chronic stroke, AOT improved gait and balance in subacute stroke, and MI was more successful in acute stroke.

Keywords: Stroke, Mirror box therapy, Action observation technique, Motor imagery technique, Rehabilitation.

INTRODUCTION

A stroke is characterized by an abrupt loss of neurological function caused by a disruption in blood flow to the brain.[1] The second most substantial cause of mortality worldwide is stroke.[2][3] There are two distinct forms of stroke. Ischemic stroke extremely prevalent form of stroke is one that endures for an extended period of time and can



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be triggered by a lack of blood flow to the brain[4][5]. Hemorrhagic stroke is an acute space-occupying lesion that compresses and disrupts the surrounding tissue and causes an increase in intracranial pressure due to that blood flow and metabolism are disturbed [5] Motor and sensory challenges are exceptionally common after stroke; 80% of stroke patients wore motor impairment, 20% of those for whom recovered within a few months, while the remainder of 50–60% have a pervasive motor dysfunction, while approximately 50% of stroke patients have sensory anomalies[6]. As a consequence, there are numerous alternative physiotherapy modes accessible one of which employs cognitive treatment to emphasize the mirror neuron system, such as Mirror Box treatment, Action Observation, and Motor Imaginary Training.[7][8] For instance, of mirror neurons to be indulged by visual inputs, a biological effector (such as the hand or mouth) has to interface with a specific object.[9] The relationship between the visual and motor features of mirror neurons is a crucial component of their functionality.[10] Mirror neurons are categorized into "strictly congruent" and "broadly congruent" neurons based on the type of parallelism they exhibit. Mirror neurons were identified and described as "strictly congruent" when the effects seen and executed actions match in terms of the aim (such as grasping) and method of achieving the goal (such as a precise grip). Broadly congruent mirror neurons have been defined as those that do not require the same action to be observed to activate as that which they code motorically.[9][10] These cognitive therapy methods are more practical, inexpensive, and the patient can perform independently and which helps to change the thoughts, emotions, and behavior of the patient.[11] Motor imagery (MI) is the process of portraying an item or a person moving.[12] Despite the presence of external stimuli, humans actively replicate actions thru a process known as motor imagery. MI technique is the ability to imagine movement visually and somasthetically to improve motor skills without performing the actual movement.[13] It is a dynamic process that incorporates kinesthetic and visual data about the movement that has been mentally practiced.[14] MI is immediately implementable and doesn't need any specific facilities or equipment. Greater functional independence could result from MI by facilitating the motor relearning process.[15] Acute, subacute, and chronic hemi paresis are all effectively treated with MI, and it additionally performs well for Parkinson's, spinal cord injury, intractable pain, and multiple sclerosis patients[16,17]. Action Observation Technique (AOT) is the simulate of attempting to imitate an action that has been seen in a video clip or is being carried out by a Person.[18] Activities can be mentally practiced or simply observed, and these acts can also cause the recruitment of motor regions.[19] In a somatotopic way, observing someone else perform an activity activates the same motor representations that are used to perform that action itself.[17] The subjects' recorded muscular response patterns and the pattern observed when they performed the motion physically were identical.[20] It seems to be beneficial for restoring function after a stroke and enhances motor function,[21] improving language deficit, Parkinson's, improving function of post orthopedic surgery[22], and cerebral palsy [23]. Mirror Box therapy (MBT) is used to improve motor recovery by giving visual stimuli. [24][25] The contra-lateral hemisphere activated when the paretic limb is moved. A paretic limb's visual representation is said to resemble a person's moving limb.[24] There are many different mechanisms underpinning rehabilitation, such as active training techniques and passive damage adaptability methods.[19] The goal of this study is to evaluate the existing research on the efficacy of many different cognitive therapies in stroke patients, such as motor imagery, action observation method, and mirror box treatment. So it will provide in-depth insight into the efficacy of different tactics, through which a physiotherapists can choose an appropriate technique for stroke patients.

With the Objectives

To assess the efficacy of Mirror box therapy, Action observation method, and Motor imaginary technique in improving stroke patients' motor and sensory function.

Non-invasive treatments such as mirror box therapy, action observation technique, and motor imaging have shown encouraging results in improving motor function in stroke patients.

A comparative study will provide physiotherapists with an in-depth insight of the efficacy of different tactics, assisting them in picking the appropriate technique for each patient



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METHODOLOGY

A thorough review of the literature was carried out utilizing internet resources such as PubMed, Google Scholar, NCBI, and Cochrane Library. "Mirror Box Therapy, Action Observation, Motor Imagery, Stroke, Rehabilitation, Therapy, and Treatment" were utilized as search phrases. The search was constrained to Articles published in English between 2005 and 2022. The initial search yielded a total of 192 articles, of which 62 studies were included in the review. After reading all abstracts and methodology, duplicates were removed, leaving 94 reviews for screening. After screening the methodology and results, and after full-text screening, 32 articles were excluded. A total of 62 studies were finally included in the review (Figure 1). Fourteen studies of the Action observation Technique, Twelve studies of Mirror box therapy, and fourteen studies of Motor Imagery technique. Inclusion criteria are: Studies that have been published in English; Stroke sufferers have been the subject of studies; Research on the use of motor imagery, action observation, and mirror box treatment as therapies; conducted between 2005 and 2022; and Randomized controlled trial is a part of the study. Exclusion criteria are: Studies that have not been published in English; Studies without participants with stroke; Research not using motor imagery, action observation, or mirror box therapy as methods; Research with a small sample size (e.g., less than 10 participants); and Review articles.

DISCUSSION

Mirror box therapy, Action observation, and motor imagery are all promising techniques used in stroke rehabilitation. These techniques aim to improve motor and sensory function. These all techniques work on the mirror neuron system. Mirror neurons are a distinct group of neurons that provide a "observation-execution matching Mechanism" capable of unifying action sensing and execution.[26] The purpose of this study is to review the effectiveness of these approaches in stroke rehabilitation. In accordance with Lee *et al.* (2012), after a period of four weeks of Mirror Therapy Program (MTP), there is a substantial rise in motor abilities of the upper limb in acute stroke patients.[27]. Yeldan *et al.* (2015) revealed that in acute stroke, MBT has no additional impact upon upper extremity functional recovery.[28] According to the study of Mathieson *et al.* (2018), suggest that the combination of mirror box therapy and functional electrical stimulation (FES) do not have the desired stacking effect on improving motor recovery. But in acute stroke FES alone shows significant improvement compared to mirror box therapy,[29] but it is only maintained when a patient takes regular physiotherapy and adjunct therapies.[30] Then in 2018, Yim and Kim *et al.* reported that Repetitive trans-cranial magnetic stimulation (rTMS) along with task-oriented mirror therapy (TOMT) shows exceptional results in terms of motor function recovery through mirror neuron system in stroke patients and shows significant improvement in grip strength, pinch grip, and box and block outcome.[31] In a study of Karamat *et al.* (2022) compared the Mirror therapy with repetitive facilitation exercise (RFE) and was found mirror therapy more effective. As in MT large number of muscles work together and it stimulates damaged muscles which improves patient upper arm function following hemiplegic stroke.[32] Study of Kang *et al.*, stated that the use of PC application based mirror therapy can improve face movement along with orofacial Exercise.[33] According to Kuys *et al.*, patients with chronic hemiparesis may gain from MBT in terms of sensation as well as motor impairments, activity limitations and participation restrictions if it is used as an active sensory-motor training program in the chronic stage.[34] Similar to a research by Lin *et al.*, using the MBT with Mesh Glove (MG) approach, which is a type of sensory-motor stimulation, significantly improved Chronic stroke patients' hand dexterity, gripping, and transfer performance.[35] Further study conducted by Lee *et al.* (2015) they combine two therapy together i.e MT alone, MT + MG, MT + sham, and they found that MT + MG and MT + Sham group showed significant improvement then MT alone in manual dexterity and ADL's.[36] Task-based mirror therapy (TBMT) was used in a research by Arya *et al.* (2015) on post-stroke patients to address the upper arm (UA), wrist-hand (WH) components. The mirror box design restricted upper-arm movements, such as shoulder rotation and overhead movement, which caused FMA-UA scores to improve less substantially than FMA-WH scores.[37] He did another research in 2018 that demonstrates the benefits of mirror therapy treatment in the healing of sensory impairment.[38] According to Lee *et al.* (2015), there is a research where they combine mirror treatment with functional electrical stimulation (FES), which is based on biofeedback, to produce integrated muscular contraction for the afflicted and



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less affected sides. Due to the fact that BF-FES provides motor input, mirror therapy provides visual biofeedback to the patient, and both treatments serve as task-oriented training for the bilateral upper extremities, patients who have had strokes have significantly improved thanks to this combination.[39] Patients were requested to visualise 18 distinct ADLs in order to improve upper extremity performance in a study by Seong-sik Kim *et al.* on the use of the motor imaginary technique as a therapeutic approach for stroke patients. After using the MIT, patients' FMA-UE scores dramatically increased from 27.92 to 36.08.[40] A study of Frolov *et al.*, "Study on sensory- motor function suggests that MI could be a promising treatment for improving cutaneous sensibility in patients with stroke. The mirror illusion prompted by MI can be utilized to make up the difference for sensory and motor deficits, as well as to differentiate between more and less affected hands".[41] Hemmen and seelen *et al.* conducting a study on movement motor imagery along with electromyography-triggered feedback for wrist Extensors but it does not show any significant improvement in arm-hand performance.[42] A motor imagery technique is to enhance functional task performance, according to Eerdt *et al.* (2010), "found that both the patient and the therapist had limited compliance with employing motor imagery. Future research must go more deeply into how this tactic is applied in clinical settings.[43] Similar concerning the way Kim and Lee *et al.* (2015) propose that motor imagery approach can enhance gait speed and balance in stroke patients.[44] When stroke patients employ the motor imagery technique to sit to stand, according to Sherin *et al.* (2022), their capacity to do so is greatly increased. It aids in transfer activity and ADLs as well.[45] According to the kim *et al.* a "study demonstrates a substantial increase in gait time and distance variables". According to the study's findings, people with post-hemiparesis may be able to walk more easily if certain acts from their motor repertoire are observed and related to gait performance.[46] Oostra *et al.* (2015) noted that motor imagery training may help subacute stroke patients with their gait function, but they also noted that more research was necessary.[47] Kumar *et al* (2016) shows similar effect to improve muscle strength of lower extremity and gait through motor imagery.[48] Another study on mental practice using motor imagery found no evidence of help in stroke patients. There was not any sign of better performance as a result of mental practice with motor imagery on any of the outcome measures.[49] Park and lee *et al* (2015) mentioned that function of upper extremity and ADL's may improve through motor imagery and mental training.[50] A study on little mental practice to improve motor task performance revealed performance gains after mental practice in any of the four groups. In this study, there was little mental practice, which might not have improved motor skills. Yet, increasing mental practice and concentration levels might enhance motor performance rather than simply making the subject's mental imagery more vivid. [51] There is a study by Page *et al.* (2005) where they used mental practise (MP) in chronic stroke patients with their most affected side. As we know, stroke patients do not use their affected arm much, so for the same reason, they use mental practise as an intervention. They found that after the 6 week of protocol (two sessions per week), changes were observed in the affected side and the individual started to use that limb more often.[52] He conducted further in 2007 study which also showed the effectiveness of programs incorporating mental practice for treating individuals with chronic stroke who have impaired a motor function.[53] "Studies on game-based virtual reality plus mental practice outcomes indicate that game-based VR movement therapy may be effective for functional recovery of the UE in chronic stroke patients, and that the effects are enhanced when the therapy is combined with MP," Park *et al* (2016) write.[54] A study by Kuk and Eun-ju *et al.* on the use of the action observation approach to treat hand dexterity in stroke patients showed a notable improvement in cortical reorganization and the activation that fosters motor memory. This result was discovered using an EEG-based brain mapping.[55] In the words of Franceschini *et al.*, AOT has the ability to carry out traditional rehabilitation by highlighting the positive effects of the action observation technique in the patients functional dexterity and primary goal to restore lost function within the damaged motor network via use-dependent plasticity, the important component of action observation is replication of the observed movement.[56] According to sale *et al.*, study shows someone move with the intent of imitating them can make some brain regions more excitable and encourage the regaining of motor function. Right hemisphere strokes improve more quickly than left hemispheric strokes when action observation and action execution are combined.[57] and in left hemisphere dominance, patients with left hemisphere lesions showed higher overall activation levels than those with right hemisphere lesions.[58] which suggest that Action observation with conventional rehabilitation can improve function in the upper extremity and daily living activities in stroke patients.[59,60] A film is shown in three phases at various speeds in the Bang *et al.* (2013) Study; to improve walking ability in chronic stroke patients, allowing participants to precisely observe walking behavior while the therapist also gives vocal instructions. The results of this





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study showed that action observation and treadmill exercise greatly enhance patients' ability to walk after chronic stroke.[61] Another study by oh and Lee *et al* examines if Functional Action-Observation (FAO) can help individuals with post-stroke hemiparesis by using a gait analysis system to measure spatio-temporal characteristics. find, functional action observation training is more successful at improving the gait of chronic stroke patients [62] Limitation, some studies have a relatively small sample size, which leads in in accurate results, while others have limited age restrictions, so the results are not applicable to the entire population. One of the virtual studies is tele-rehabilitation, which cannot be adequately evaluated. Some studies were completed in a short period of time, while others required an inordinate amount of time to complete. Some studies just look at hand functions, while others look at gait and balance as a whole.

CONCLUSION

We came to the conclusion from this study that all three stroke treatment methods are efficient. Both MBT and MI significantly improve at the acute stage, but MI does so more dramatically than MBT. All three treatment modalities—MBT, AOT, and MI—show considerable improvement in subacute stroke patients, although AOT produces the best outcomes. All three techniques are helpful in the chronic period; although MBT demonstrates the most improvement in hand function. AOT is superior to MI for enhancing gait function and balance.

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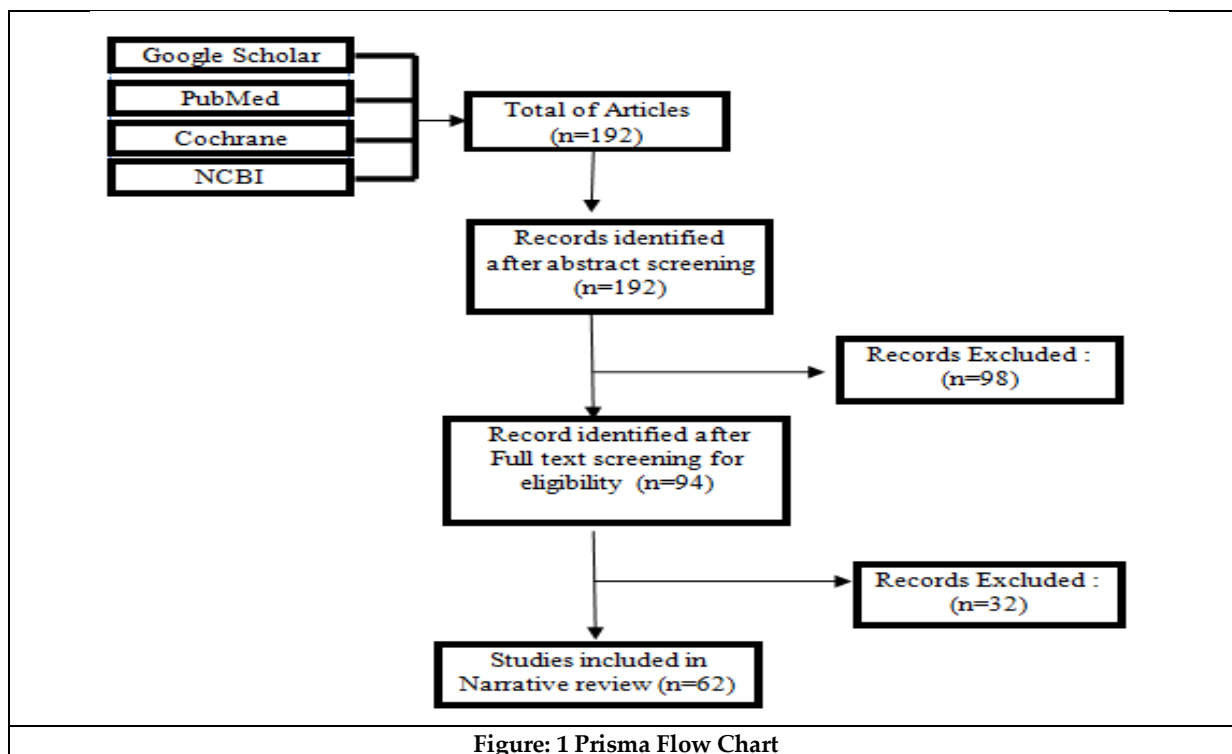
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Phytochemical Screening and Evaluation of Anthelmintic Activity of *Thespesia populnae* by *In-Vitro* Methods

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ABSTRACT

The whole plant extract of *Thespesia populnea* was subject to anthelmintic activity. The ethanol extract showed a good anthelmintic property when compared to other extracts. Also, the phytoconstituents were also investigated and analysed. Albendazole was used as a standard drug for anthelmintic activity. The ethanolic extract showed a moderate time of paralysis and death in the worms. These results indicate that the phytoconstituents may possess an anthelmintic activity. The anthelmintic effect of the extract *in-vitro* may either be the effect of the individual phytoconstituents or synergistic effect of the phytoconstituents.

Keywords: *Thespesia populnea*, *in-vitro*, anthelmintic, Albendazole,

INTRODUCTION

Thespesia populnea, commonly known as the **Portia tree**, **Pacific rosewood**, **Indian tulip tree**, or **milo**, among other names, is a species of flowering plant belonging to the mallow family, *Malvaceae*. It is a tree found commonly on coasts around the world. Although it is confirmed to be native only to the Old World tropics, other authorities consider it to have a wider, possibly pantropical native distribution. It is thought to be an invasive species in Florida and Brazil.





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Leaf Description

Simple leaf, heart shaped with long stalk. stipules 4-10 mm long, free, lateral, linear to lanceolate, caudaceous; petiole 5-10 cm, slender, swollen tipped, scaly; lamina 5-12.7 x 5.5-15 cm, orbicular or ovate, base cordate or truncate, apex acute or acuminate, margin entire or dentate, coriaceous, with peltate scales above, glabrescent or stellate-tomentose beneath; 5-7 nerved from the base, palmate, prominent, lateral nerves 4-5 pairs, pinnate, prominent, intercostaesubscalariform, prominent, often a glandular pore in one or more of the intercostal spaces beneath.

Treatment

Albendazole was highly effective against *Ascaris lumbricoides*, *Ancylostoma duodenale* and *Enterobius vermicularis*. Significant improvement was also observed in patients having infections due to *Trichuris trichiuria*. The primary drugs used for cestode infections are albendazole and praziquantel. It is a broad-spectrum anthelmintic affecting both flukes and tapeworms. Diethylcarbamazine and ivermectin, used for treating filarial worm infections, are absorbed from the intestinal tract. Benzimidazoles, macrocyclic lactones, levamisole, piperazine and amino-acetonitrile derivatives may be used to treat almost all these parasites and lower infection levels below clinical relevance. However helminth resistance to these medications have been documented in certain publications, which is typical in the field of veterinary medicine. Plants produce a broad spectrum of secondary metabolites or phytochemicals which aid in several biological activities including the defence of the plant against pests and diseases. The major classes of phytochemicals include phenolic, alkaloids, flavonoids and terpenoids compounds. These phytochemicals make some plants a good source of remedy for ailments.

Plant secondary metabolites have been successfully used in ethnomedicine and are generally used for insecticide, pesticidal, molluscicidal, antimicrobial, antiparasitic and other ailments. Drug resistance in helminths threatens human and animal health across the world. Understanding the genetics and mechanisms of helminth medication resistance is critical for preventing resistance to newly discovered anthelmintic treatments, reducing the dissemination of resistant parasites, and effectively managing parasite management at all phases of their lifecycle. Resistance to gastrointestinal nematodes, as well as other parasitic worms such as liver fluke, has been shown to be high in ruminants. As a result, parasitological research into the causes of anthelmintic resistance is required in order to create new treatment techniques and medications for helminth control. The major approach for discovering novel anthelmintic medications were centred mostly on screening new compounds using in vitro and in vivo test system.

Helminthiasis

Helminthiasis, commonly known as **worm infection**, is a macro parasitic disease in which a part of the body is infected with parasitic worms or helminths. There are several species of parasites and they often reside in the digestive tract of the host body. Helminths either live as parasites, or free of a host, in aquatic and terrestrial environments. The most common worldwide are intestinal nematodes or soil-transmitted helminths (STH), schistosomes (parasites of schistosomiasis) and filarial worms, which cause lymphatic filariasis (LF) and onchocerciasis. Soil-transmitted helminthiasis and schistosomiasis are the most important helminthiasis and are among the neglected tropical diseases. A parasitic worm's lifecycle may be quite complicated, with several hosts for different stages; also, a significant adaptation utmost parasitism of a worm is a complex lifecycle incorporating tropic transmission. Some helminths (soil-borne nematodes) such as *Strongyloides* and Hookworms have a free-living stage (Rhabditiform larvae) and a parasitic stage (Filariform larvae) that may need a different host or environment.

EXPERIMENTAL METHODS

The plant sample was washed with distilled water for several times and subjected to air dried under the shade. After drying they were ground by an electrical mixer until it become powder. About 160 g of dried sample powder was weighed and extraction process is carried out in Soxhlet extractor by using 200 ml of ethanol in rotary shaker at 150 rpm at 25 °C temperature for 72 h. The extracts were filtered using Whatman No.1 filter paper, the filtrate was





concentrated by a rotary evaporator, and the residual extracts were dried under vacuum desiccator, and stored for further use of phytochemical studies.

Preliminary Phytochemical Screening

The preliminary phytochemical analysis was carried out for the presence of terpenoids, flavonoids, steroids, anthraquinones, glycosides, carbohydrates, alkaloids, quinones, phenols, tannins, saponins, proteins and amino acids.

Test for alkaloids: Mayer's Test: To the extract, 2 ml of Mayer's reagent was added; formation of reddish-brown precipitate indicates the presence of alkaloids.

Test for saponins: To 1 ml of the extract, 5 ml of water was added and the tube was shaken vigorously. Copious lather formation indicates the presence of saponins.

Test for tannins: To the extract, ferric chloride was added, formation of a dark blue or greenish black color showed the presence of tannins.

Test for cardiac glycosides: Keller-Killani test: To 1ml of the extracts, 2 ml of glacial acetic acid containing a drop of FeCl_3 . Equal volume of conc. H_2SO_4 was added from the sides of the tube. A brown color ring indicates the presence of cardiac glycosides.

Test for flavonoids: Alkaline reagent test: Extract was treated with 10% NaOH solution; formation of intense yellow colour indicates presence of flavonoid.

Test for phenols: Lead acetate test: The extract was taken; 3 ml of 10% lead acetate solution was added. A bulky white precipitate indicated the presence of phenolic compounds.

Test for steroids: 1 ml extract was dissolved in 10 ml of chloroform & equal volume of concentrated H_2SO_4 was added from the side of test tube. The upper layer turns red and H_2SO_4 layer showed yellow with green fluorescence. This indicates the presence of steroid.

Test for terpenoids: Salkowski test: 5 ml of extract was mixed in 2 ml of chloroform, and concentrated sulphuric acid was carefully added to form a layer. A reddish-brown coloration of the interface indicates the presence of terpenoids.

Test for Quinones: The extracts were treated separately with Alc. KOH solution. Appearance of colors ranging from red to blue indicates the presence of quinones.

Test for Proteins: Ninhydrin test: The extract was taken and few drops of freshly prepared Ninhydrin reagent was added and heated. The appearance of pink or purple colour indicates that the presence of proteins, peptides or amino acids.

In-Vitro Anthelmintic Activity

The anthelmintic activity was tested on the Indian adult earthworm *Eiseniella fetida* using technique described by Ghosh et al. The standard medicine, Albendazole was diluted with normal saline to produce concentration of 2.5, 5 and 10 mg/ml and placed onto Petri plates. Ethanolic extracts were diluted with normal saline to reach concentrations of 2.5, 5 and 10mg/ml. The negative control was plain saline (0.9 percent NaCl). All of these dilutions were carefully put onto the petri dishes. The study used six earthworms ($n = 6$). At room temperature, earthworms roughly identical size (approximately 8cm) was inserted in each Petri dish. The time for paralysis was recorded when no movement of any kind could be detected, save when the worms were severely agitated. After determining that the worms did not move when shook forcefully or dunked in warm water, the time of death was recorded (50°C). The paralysis and fatal times were measured in minutes.

RESULTS AND DISCUSSION

In-Vitro Anthelmintic Activity

In-vitro anthelmintic activity was measured, as well as the paralysis and fatal times. The data was statistically evaluated using one-way ANOVA. The findings were reported as mean SD. The table shows the paralysis and death





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times of both standard and ethanolic extracts, as well as the norm. The study found that both standard and ethanolic extract of *Thespesia populnea* exhibited substantial efficacy at higher concentrations (10mg/ml). Each value in the table is represented as mean \pm SEM *P < 0.05 compared with standard drug Albendazole. The extracts were subjected to anthelmintic activity with albendazole as standard drug. Albendazole at 2.5mg/ml paralyzed the worm at 53.80 ± 3.45 minutes and caused death at 110.38 ± 3.45 minutes. The ethanol extract showed a close range of paralysis and death similar to albendazole at 10mg/ml. At this concentration the worms paralyzed at 52.64 ± 3.46 minutes and death at 118.42 ± 2.61 minutes.

CONCLUSION

The whole plant extract of *Thespesia populnea* was subject to antioxidant and anthelmintic activity. The ethanol extract showed a good antioxidant property and anthelmintic property when compared to other extracts. Also, the phytoconstituents were also investigated and analysed. Albendazole was used as a standard drug for anthelmintic activity. The ethanolic extract showed a moderate time of paralysis and death in the worms. The antioxidant activity of the ethanolic extract was studied. The absorbance of the mixture was measured at 517 nm. Ascorbic acid was used as the reference standard. These results indicate that the phytoconstituents may possess an anthelmintic activity. The anthelmintic effect of the extract *in-vitro* may either be the effect of the individual phytoconstituents or synergistic effect of the phytoconstituents.

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Table: 1 Preliminary phytochemical screening

SAMPLE	TPSJ
Alkaloids	–
Flavonoids	–
Saponins	–
Tannins	+
Phenols	+
Cardiac glycosides	+
Steroids	+
Terpenoids	+
Quinones	+
Proteins	+

+ Present

- Absent

The ethanolic extract were prepared and subjected to phytochemical screening. The investigation revealed the presence of steroids, glycosides, tannins, terpenoids, proteins, quinones, phenols, saponins, flavonoids and alkaloids.

Table :2 Analysis of paralysis and death of worms

S. No.	Treatment	Time taken for paralysis	Time taken for Death
1.	Control (Saline water)	0.00	0.00
2.	Albendazole (2.5mg/ml)	53.80 ± 3.45	110.38 ± 3.45
	(5mg/ml)	46.62±5.31	100.61± 1.34
	(10 mg/ml)	35.92 ± 2.34*	84.32 ± 4.76*
3.	Ethanolic extract (2.5 mg/ml)	80.15 ± 2.64	145.62 ± 2.55
	(5mg/ml)	70.61± 1.90	138.73±4.73
	(10mg/ml)	52.64± 3.46	118.42± 2.61





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Figure 1: Control saline



Figure 2: Albendazole 2.5mg/ml



Figure 3: Albendazole 5mg/ml



Figure 4: Albendazole 10mg/ml



Figure 5: Ethanolic extract 2.5mg/ml



Figure 6: Ethanolic extract 5mg/ml



Figure 7: Ethanolic extract 10mg/ml





RESEARCH ARTICLE

Branching Out to Safeguard India's Tomato Crop: A Novel Decision Tree Approach for Late Blight Disease Prediction

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ABSTRACT

Agriculture is a cornerstone of India's economy, constituting 20.19% of its GDP. Tomatoes, as the country's leading agricultural export, face challenges due to climatic factors and diseases, with leaf disease significantly impacting crop yield and quality. This paper presents an innovative machine learning approach, leveraging the Decision Tree algorithm, to predict Late Blight Disease in tomato leaves. A comprehensive dataset encompassing various leaf attributes was collected and used for model training. The Decision Tree, chosen for its interpretability and capacity to capture intricate data relationships, underwent rigorous evaluation via cross-validation. This research advances precision agriculture by offering a dependable tool for early disease detection, enabling timely interventions and minimizing crop losses. The simplicity and effectiveness of the Decision Tree algorithm enhance its value in sustainable farming practices. Experimental results showcase the superior performance of our method, surpassing existing literature-based approaches. This work heralds a promising path towards safeguarding India's vital tomato crop and bolstering agricultural sustainability.

Keywords: Agriculture, Tomato, Late Blight Disease, Machine Learning, Decision Tree Algorithm, Precision Agriculture

INTRODUCTION

Agriculture stands as the cornerstone of India's economy, playing a pivotal role in both GDP contribution and providing livelihoods to a vast population. Amidst the plethora of agricultural products cultivated across the country, tomatoes hold a special significance. They are not only a staple in Indian cuisine but also a prominent



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agricultural export, contributing significantly to the nation's economic prosperity. However, the tomato crop in India faces formidable challenges, primarily arising from climatic factors and various diseases. Among these challenges, Late Blight Disease emerges as a significant threat, imposing severe impacts on both crop yield and quality [1]. Late Blight Disease, caused by the pathogen *Phytophthora infestans*, is notorious for its rapid spread and devastating effects on tomato plants. The disease manifests as dark, irregularly shaped lesions on the leaves, ultimately leading to the withering and death of the plant. In a country where agriculture is the lifeline, the consequences of Late Blight Disease can be dire. A detail picture of these shown in Fig 2. Farmers often struggle to detect and manage the disease in its early stages, resulting in substantial crop losses and economic hardship [2]. In recent years, the fusion of technology and agriculture, known as precision agriculture, has emerged as a promising solution to address such challenges. Within this realm, machine learning, a subset of artificial intelligence, has gained momentum, offering innovative approaches to combat crop-related issues. The evolution of machine learning, as depicted in Figure 1, showcases various stages of its development, ushering in numerous advancements and fresh ideas across diverse fields.

This paper centers on one such innovative approach—a Decision Tree-based predictive model for the early detection and management of Late Blight Disease in tomato plants. The driving force behind this research lies in the urgent necessity to safeguard India's tomato crop, which serves as a vital component of the country's food security and contributes significantly to export revenue [3]. To achieve this goal, an exhaustive dataset comprising various leaf attributes was painstakingly collected and employed for model training. The Decision Tree algorithm was selected as the primary tool for disease prediction owing to its interpretability and its capacity to capture intricate relationships within the data. The significance of early disease detection cannot be overstated. Timely interventions, such as targeted pesticide application or altered irrigation practices, can significantly mitigate the impact of Late Blight Disease. The simplicity and effectiveness of the Decision Tree algorithm enhance its value in sustainable farming practices, empowering farmers with a practical tool for disease prediction [4]. This research contributes to the ongoing discourse on precision agriculture and disease management by offering a reliable and easily interpretable tool for the early detection of Late Blight Disease. The paper underscores its significance by demonstrating the superior performance of the proposed Decision Tree-based model compared to existing literature-based approaches. In doing so, it lays the groundwork for a promising future in safeguarding India's vital tomato crop and bolstering agricultural sustainability [5]. As we delve deeper into this research, we will explore the methodology, dataset, model development, evaluation, and the implications of this innovative approach in the context of India's agricultural landscape. Through this, we aim to shed light on the immense potential of machine learning in addressing critical challenges in agriculture and propelling sustainable farming practices forward, thereby securing the future of India's agricultural sector. The key contributions of the work titled "Branching Out to Safeguard India's Tomato Crop: A Novel Decision Tree Approach for Late Blight Disease Prediction" are as follows:

Innovative Machine Learning Approach: The paper introduces an innovative machine learning approach for the early detection and management of Late Blight Disease in tomato plants, which is a significant threat to India's tomato crop.

Decision Tree Algorithm: The study employs the Decision Tree algorithm as the primary tool for disease prediction due to its interpretability and its ability to capture complex data relationships. This algorithm enhances the simplicity and effectiveness of disease prediction, making it a valuable tool for sustainable farming practices.

Comprehensive Dataset: An exhaustive dataset containing various leaf attributes relevant to Late Blight Disease in tomato plants was collected and utilized for model training. This dataset forms the basis for the predictive model's development and evaluation.

Contribution to Precision Agriculture: The research aligns with the concept of precision agriculture, offering a reliable and easily interpretable tool for early disease detection. Timely interventions based on this tool, such as



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targeted pesticide application or adjusted irrigation practices, can significantly reduce the impact of the disease.

Superior Performance: The experimental results demonstrate the superior performance of the proposed Decision Tree-based model compared to existing literature-based approaches for Late Blight Disease prediction. This showcases the effectiveness of the novel approach in addressing a critical agricultural challenge.

Significance for India's Tomato Crop: Given the vital role of tomatoes in India's economy and food security, this work has direct implications for safeguarding the tomato crop, minimizing crop losses, and bolstering agricultural sustainability.

Contribution to Future Agriculture: The paper contributes to the ongoing discourse on precision agriculture and disease management, emphasizing the potential of machine learning in addressing critical challenges in agriculture. It lays the groundwork for future research and applications in securing the future of India's agricultural sector.

Related Works

In the realm of plant disease detection, particularly in the context of Late Blight Disease in tomato plants, several noteworthy studies have delved into the application of machine learning and image processing techniques. Mehmood *et al.* (2019) utilized Convolutional Neural Networks (CNNs) for accurate disease recognition but noted the black-box nature of CNNs [6]. Meena and Chandrasekar (2019) conducted a review on various image processing methods, highlighting the computational resources they may demand [7]. Singh *et al.* (2020) offered a comprehensive exploration of machine learning approaches, including decision trees and neural networks, in plant disease prediction [8,9]. Senthilnath *et al.* (2020) surveyed the use of deep learning techniques, emphasizing CNNs, in image segmentation for precision agriculture [10,11]. Naveen Kumar *et al.* (2021) employed various machine learning algorithms for tomato disease detection [12], while Patil *et al.* (2021) focused on deep learning methods like CNNs and recurrent neural networks [13]. However, this current research distinguishes itself by adopting the Decision Tree algorithm, prioritizing interpretability, and potentially facilitating widespread adoption in precision agriculture. With its comprehensive dataset and superior performance, this study contributes significantly to safeguarding India's tomato crop and promoting agricultural sustainability [14,15].

Proposed Work

The proposed work aims to address the challenges associated with the identification and detection of tomato leaf diseases through traditional naked eye observations, which are often less accurate and limited in scope. Additionally, accessing agricultural experts for crop inspections can be costly and time-consuming for farmers and agriculturalists. To overcome these issues, we leverage recent advancements in computing technology, specifically AI and machine learning, to develop a computerized system for the automatic detection of tomato leaf diseases, facilitating the monitoring of large tomato crops.

Our approach employs a decision tree classifier, a supervised machine learning algorithm, to predict the presence of late blight diseases in tomato leaves based on certain key features. These features include:

- Contrast
- Homogeneity
- Energy
- Correlation
- Dissimilarity

The prediction of disease is based on the symptoms identified in the dataset, and our algorithm makes use of these features to make accurate predictions. Through rigorous training and fine-tuning of the models, incorporating various hyperparameter modifications, we have achieved an impressive accuracy rate of 99%. These promising results demonstrate the effectiveness of our approach in disease detection.

The advantages of employing these machine learning techniques in agricultural disease detection are manifold. They are not overly resource-intensive, reducing the need for extensive labor and minimizing the likelihood of errors in



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disease diagnosis. By harnessing the power of AI and machine learning, we aim to provide an efficient and cost-effective solution for farmers and agriculturalists to monitor and protect their tomato crops from diseases, ultimately contributing to improved crop yields and food security [16].

Proposed Algorithm

Here is the proposed algorithm for the automatic detection of tomato leaf diseases using a Decision Tree classifier:
Algorithm for Tomato Leaf Disease Detection using Decision Trees

Step 1: Data Collection

- Gather a comprehensive dataset containing features related to tomato plants.
- Include information such as leaf color, texture, size, shape, and environmental factors like temperature, humidity, and rainfall during the growing season.
- Ensure the dataset includes labels indicating whether tomato plants are infected with Red Blast Disease (late blight) or not.

Step 2: Data Preprocessing

- Handle missing values, outliers, and inconsistencies in the dataset.
- Normalize or standardize numerical features to ensure similar scales.
- Encode categorical variables if necessary.
- Split the dataset into training and testing sets for model evaluation.

Step 3: Feature Selection

- Utilize feature selection techniques to identify the most important features for predicting Red Blast Disease.
- Decision Tree algorithms naturally rank features by importance during the tree-building process.
- Evaluate feature importance using techniques like Information Gain, Gini Impurity, or other criteria specific to Decision Trees.

Step 4: Building the Decision Tree Model

Initialize the tree with the root node, say S , which contains the complete dataset.

- Find the best attribute in the dataset using Attribute Selection Measure (ASM).
- Divide S into subsets that contain possible values for the best attribute.
- Generate a decision tree node containing the best attribute.
- Recursively create new decision trees using the subsets of the dataset created in Step 3.
- Continue this process until a stage is reached where you cannot further classify the nodes, and label this final node as a leaf node.

Step 5: Prediction

- To make predictions, traverse the decision tree starting from the root node.
- For each internal node, follow the branch that corresponds to the value of the selected attribute.
- Repeat this process until a leaf node is reached.
- The label associated with the leaf node represents the predicted class (infected or not infected with Red Blast Disease).

Step 6: Model Evaluation

- Evaluate the Decision Tree model's performance using the testing dataset.
- Calculate metrics such as accuracy, precision, recall, and F1-score to assess the model's effectiveness in disease detection.

Step 7: Model Deployment

- Once the model achieves satisfactory performance, deploy it as a computerized system for automatic detection of tomato leaf diseases in real-world applications.
- This algorithm outlines the process of collecting data, preprocessing it, selecting relevant features, building a Decision Tree model, making predictions, evaluating the model, and deploying it for practical use in monitoring and protecting tomato crops from Red Blast Disease.

Pseudo code

Here's a pseudo-code presentation of the proposed algorithm for predicting Red Blast Disease in tomato leaves using



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a Decision Tree algorithm:

```
# Step 1: Data Collection
# Gather a comprehensive dataset
dataset = gather_tomato_dataset()
# Step 2: Data Preprocessing
# Clean and format the raw data
cleaned_data = preprocess_data(dataset)
# Step 3: Feature Selection
# Identify and select important features
selected_features = feature_selection(cleaned_data)
# Step 4: Building the Decision Tree Model
# Train the Decision Tree model
model = train_decision_tree_model(selected_features)
# Step 5: Cross-validation Technique
# Evaluate model performance using k-fold cross-validation
evaluation_metrics = cross_validation(model, selected_features)
# Step 6: Model Evaluation and Deployment
# Analyse cross-validation results
analyze_results(evaluation_metrics)
# Fine-tune hyperparameters if necessary
tune_hyperparameters(model, selected_features)
# Deploy the model for practical use
deploy_model(model)
```

This pseudo-code outlines the main steps of the algorithm, from data collection and preprocessing to model training, evaluation, and deployment. You would need to implement each function or step in a programming language of your choice to create a working predictive model for Red Blast Disease in tomato leaves using a Decision Tree algorithm.

Visualization

- Data visualization assists in exploring business insights to achieve business goals in the right direction. It helps to correlate the data from the visual representations or graphical representations. It allows for fast analysis and instantly digests critical metrics.
- It enables enterprises to stay on top of their game by discovering the latest trends through data visualization tools.

Without data visualization, businesses would have to spend tons of their time customizing reports and modifying dashboards, replying to ad hoc requests, etc. The benefits of Data visualization tools optimize and instantly retrieve data via tailor-made reports, which significantly cuts down on employee time shown in figure3.

Model Evaluation and Deployment

- Analyze the results of cross-validation to determine the model's performance.
- Fine-tune hyperparameters if necessary to optimize model performance
- Once satisfied with the model's performance, it can be deployed in a practical setting for early detection of Red Blast Disease in tomato plants

Comparison Study

Comparative Analysis of the Algorithms

Based on the performance metrics, the Decision Tree algorithm shows the highest accuracy, precision, recall, and F1-score among the algorithms considered. Hence, Decision Tree is identified as the most effective algorithm for



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detecting Late blight disease on tomato leaves.

RESULT ANALYSIS

In the Result Analysis section of our research, we conducted an extensive comparative study of various machine learning algorithms aimed at detecting Late Blight Disease on tomato leaves. Our evaluation encompassed essential performance metrics, including accuracy, precision, recall, and F1-score. Among the algorithms we assessed, the Decision Tree algorithm emerged as the standout performer, achieving an outstanding accuracy rate of 99%. Furthermore, it demonstrated perfect precision and a substantial recall rate of 99%, resulting in an impressive F1-score of 0.99. This exceptional performance underscores the Decision Tree algorithm's effectiveness in accurately identifying and detecting Late Blight Disease, positioning it as the preferred choice for practical applications in tomato crop disease monitoring shown in figure 4. Our study underscores the potential of AI and machine learning in revolutionizing agricultural disease detection. It offers a dependable and efficient solution that can significantly enhance crop yields and food security while simultaneously reducing the resource-intensive demands associated with traditional methods. It's important to note that interpreting Decision Tree results should always be done within the context of the specific problem and dataset under consideration. Decision Trees are powerful tools for both classification and regression tasks, and a thorough understanding of their results is essential for extracting meaningful insights.

CONCLUSION AND FUTURE WORK

In conclusion, our research has demonstrated the remarkable effectiveness of the Decision Tree algorithm in detecting Late Blight Disease on tomato leaves, showcasing its superiority over other machine learning algorithms in terms of accuracy, precision, recall, and F1-score. This underscores the immense potential of AI and machine learning in revolutionizing agricultural disease detection, offering a reliable and efficient solution that can substantially improve crop yields and food security while reducing resource-intensive demands associated with traditional methods. However, for future work, we acknowledge the need for continued research in several areas. Firstly, further refinement of the Decision Tree model through hyperparameter tuning and the exploration of ensemble methods could potentially enhance its performance even further. Additionally, expanding the dataset to include a broader range of environmental factors and incorporating real-time monitoring systems would contribute to more robust disease detection in practical agricultural settings. Lastly, exploring the scalability and integration of this technology into precision agriculture systems and IoT devices represents a promising avenue for future research, allowing for early disease detection and proactive disease management in large-scale farming operations.

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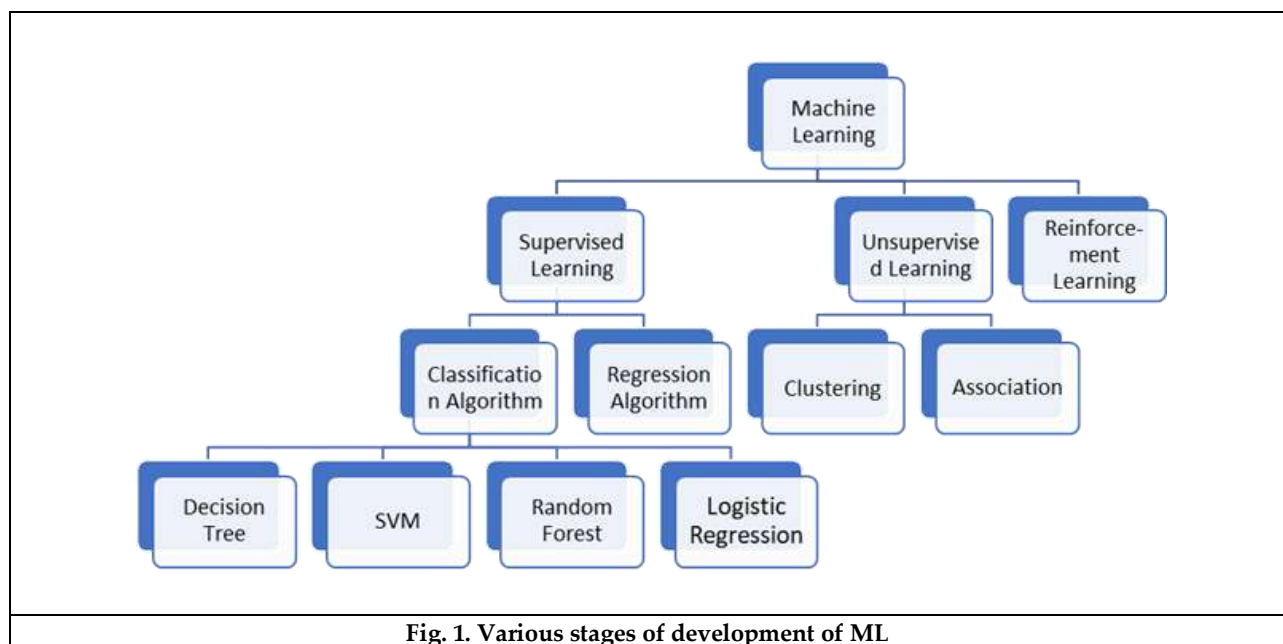


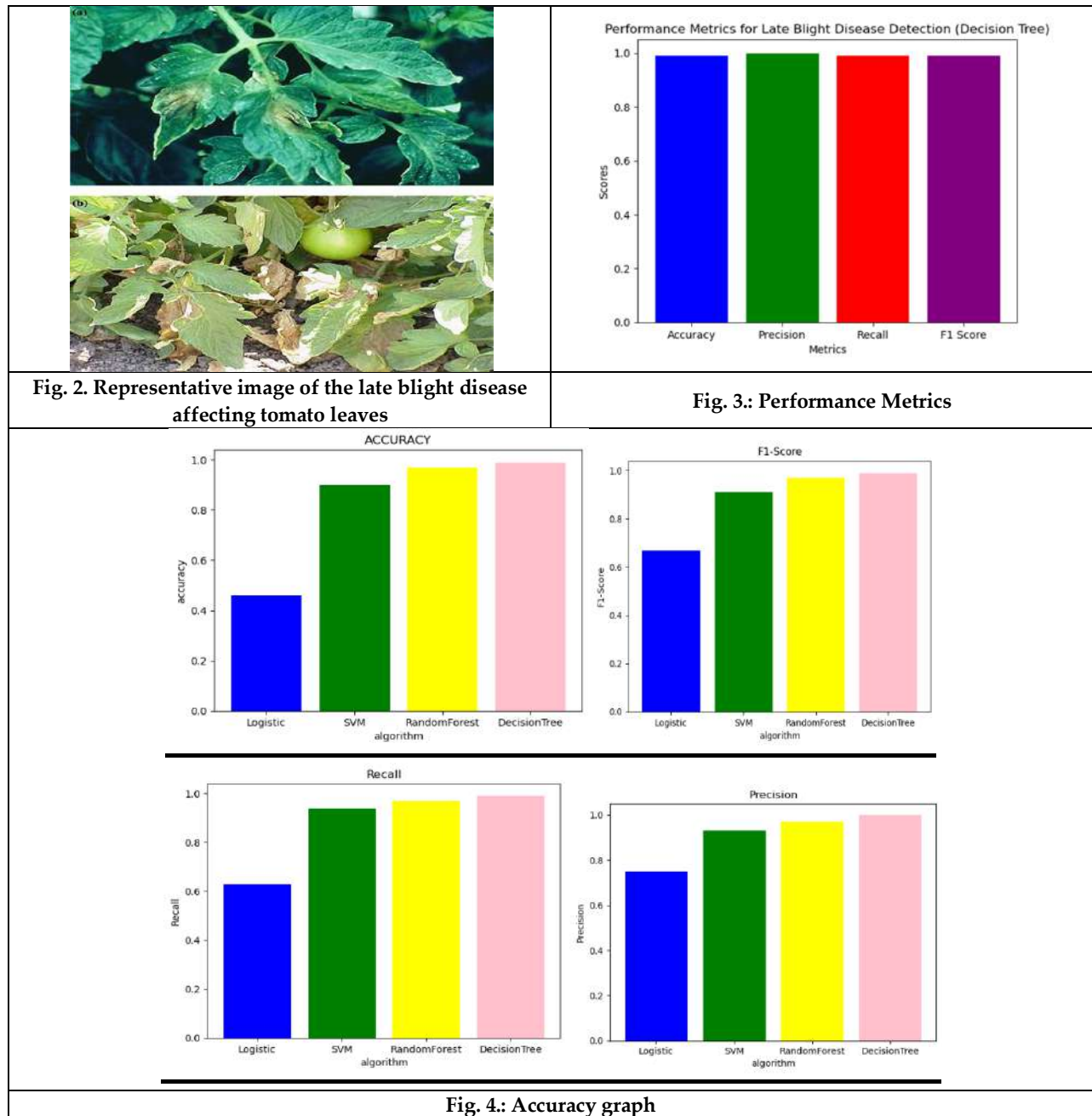
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Table 1. Comparison of Machine Learning Algorithms for Late Blight Disease Detection on Tomato Leaves

Index	Algorithm Name	Accuracy	Precision	Recall	F1-score
1	Support Vector Machine (SVM)	0.90	0.93	0.94	0.91
2	Random Forest	0.97	0.97	0.97	0.97
3	Logistic Regression	0.46	0.75	0.63	0.67
4	Decision Tree	0.99	1.00	0.99	0.99







Antioxidant and Antibacterial Activity of Grape Seed Extract

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ABSTRACT

One of the fruits that is most often consumed worldwide is the grape. In addition, it is a rich source of fiber and vitamins. Grape skin and seeds contain a lot of polyphenol developed in lipid oxidative was measured by thiobarbituric acid reactive substance (TBARS) and antioxidant activity minimum growth inhibitory concentration MIC grape seed extract done by dilution method the contact hemolysis of the grape seed extract they carried out by this method then, the percentage of hemolysis was found to be reduced in the presence of seed extract resveratrol. When compared to the control tube containing RBC and bacterial stain.

Keywords: grape seed extract, resveratrol, shigella flexneri, antioxidant, antibacterial

INTRODUCTION

The largest fruit crop in the world is grapes (*Vitis vinifera*), which produce around 58 million metric tonnes annually (FAO year book, 1997). Monomeric phenolic compounds found in grape seeds, such as dimeric, trimeric, and tetrameric procyanidins, as well as (+) catechins, (-) epicatechins, and (-) epicatechin-3-O-gallate have anti-mutagenic and antiviral properties (Saito *et al.*, 1998). The red grape is a berry that ripens found on woody, evergreen vines belonging to the genus *Vitis vinifera*. In addition to being consumed fresh, grapes can be used to make wine, jam, grape seed oil, vinegar, raisins, juice, and jelly (Patrice *et al.*, 2016). Many studies have been conducted on the *Vitis Vinifera* composition as well as characteristics of grape seeds, and they have revealed a number of benefits for human health, including a reduction in low density lipoprotein. (Vignat *et al.*, 2003, Teissedre *et al.*



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al., 1996, Frankel *et al.*, 1995. Many organizations have investigated the antibacterial, anticancer, antihypertensive, antihyperglycemic, cardiovascular, and hypercholesterolemic grape seed extract's (GSE) effects (Hong and Yimin, *et al.*, 2006; Broker *et al.*, 2006 ;). Vitis vinifera seed extracts contain antibacterial and characteristics that scavenge free radicals (Jayaprakasha *et al.*, 2001), lowering the risk of chronic disease by preventing damage caused by free radicals (Cailliet *et al.*, 2006; Gorinstein *et al.*, 1994) due to its lipid peroxidation inhibition and radical scavenging activity, and lessen the possibility of stroke. (Uchida *et al.*, 1995). A study was conducted to evaluate the antibacterial activity of Vitis vinifera seed extracts against both Gram positive and Gram negative bacteria, including Escherichia coli and Pseudomonas aeruginosa. The study's targets were Staphylococcus aureus and Bacillus subtilis. (E.Q. Xia *et al.*, 2016).

Oxidative Stress and Antioxidants

Comparing grape seed polyphenol. Its antioxidant activity is higher when compared to additional well-known antioxidants (beta-carotene, vitamin C, and vitamin E). It also has several enzymes that cause allergies and inflammation by catalyzing the production of histamine in addition to their antioxidant properties (Amitava and Kimberly 2014). It is obvious that an imbalance between oxidative and anti-oxidative processes causes oxidative damage. Species of reactive nitrogen (RNS), reactive oxygen species (ROS), and chlorinated compounds are some examples of the harmful oxidants that are produced in excess and lead to oxidative processes. Enzymatic and non-enzymatic compounds might be regarded as protective agents. Tocopherol, another name for vitamin E, and vitamin C, sometimes referred to as ascorbic acid, are two of the most crucial non-enzymatic antioxidants for preventing ROS and lipid peroxidation. (Rice-Evan *et al.*, 1995, Diplock *et al.*, 1993) which act synergistically.

Glutathione

Antioxidant enzyme activity and glutathione concentrations in grape seed and peel extract or powder feeding groups. The normal group's glutathione content was substantially less than what the cholesterol group experienced (P 0.05). Also, it was shown that cholesterol levels were significantly reduced in the grape seed and grape seed extract and peel powder collectives (P 0.05). However, there was no appreciable difference in the glutathione content of GSE and cholesterol (M.H. Kang *et al.*, 2010). In addition to its reduced and oxidized forms, glutathione can also be covalently linked to proteins through a process known as glutathionylation. (Thomas *et al.*, 1995, Hung *et al.*, 2002). The total redox status of the cell affects the ratio of GSH to GSSG. The two enzymes are glutathione synthetase and glutamyl cysteine synthetase (GCS). Involved in the enzymatic synthesis of glutathione, with GCS serving as the rate-limiting enzyme. (Lu Schematic *et al.*, 1998).

Glutathione and Disease

A broad phrase used to describe the generation of reactive oxygen, nitrogen, or iron species, oxidative stress, and the cell's overall redox condition. GSH and GSSG measurements can be used to determine the level of oxidative stress, which is typically reported as their ratio. It's interesting to note that GSH oxidizes to GSSG with age, presumably indicating the buildup of oxidative stress (Jones *et al.*, 2002). The development of malignancies is likewise correlated with a reduced GSH to GSSG ratio (Lusini, *et al.*, 2001) and individuals with chronic illnesses, such as those affecting the genitourinary, digestive, cardiovascular, and musculoskeletal systems, had lower levels of total glutathione (Lang *et al.*, 2000). Studies on the polyphenols present in green tea and grape seed extract were carried out in the middle of the 1990s. Green tea contains a significant amount of epigallocatechin-3-gallate as a polyphenol (EGCG). It is said to have an antioxidant capacity that is 15–20 several times more than the amounts of vitamins C25 and E. (Vschedea, 2010). Phenolics, anthocyanins, and other flavonoid molecules are mostly responsible for the plant tissues' compounds with antioxidant potential (Cao *et al.*, 1997). Certain flavonoids, including quercetin, are thought of as dietary antioxidants because of their capacity as free radical scavengers. Epidemiological studies have



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demonstrated an unfavorable link between dietary flavonoid intake and coronary heart disease mortality because they prevent low-density lipoprotein oxidation and decrease platelet aggregability. (Cook, *et al.* 1996). Many grape juice flavonoids, including catechin, epicatechin, quercetin, and anthocyanins, are known to have antioxidant, anti-inflammatory, and platelet-inhibitory properties. They can also decrease LDL oxidation and oxidative DNA damage in both in vitro and animal experiments. (Singletary *et al.*, 2003).

Resveratrol

Antioxidant resveratrol has a phytoalexin structure. It is mostly present in the skins of red grapes and exhibits hydroxyl-radical scavenging activity, quenching the superoxide anion and preventing the generation of hydrogen peroxide. (Nikita Wilson 2009). A diphytoalexin produced biologically is resveratrol. Since red wine contains the grape peel, which is where resveratrol is concentrated, red wine has significantly higher levels of resveratrol than white wine. Resveratrol among other plants, grapes have a naturally occurring phytoalexin called (3,5,4'-trihydroxyl-trans-stilbene). Its presence in red wine has been suggested to provide health benefits at concentrations ranging from 0.1 to 15 mg/L. (L. Fremont, *et al.*, 2000) is linked to the "French paradox," which claims that regular wine drinking, which is popular in various regions of France, lowers the death rate from coronary heart disease despite eating a lot of fat. (G.J. Soleas *et al.*, 1997).

General Introduction of shigella:

Shigellosis, bacterial dysentery that affects 165 million people annually and kills 1.1 million people, predominantly young children under the age of five, occurs in the poor countries. (Kottloff *et al.*, 1999) *Shigella flexneri* is the most common agent of endemic shigellosis and the main cause of epidemic dysentery, making it the causative agent for acute diarrheal illness. Shigellosis vaccine development is ranked first on the World Health Organization's list of priorities for the diarrheal disease vaccine. *Shigella flexneri* vaccines are being developed, but there are still many unanswered concerns regarding the disease loads. The genus *Shigella* contains four species of bacteria that cause shigellosis, encompassing 12 serotypes of *S. dysenteriae*, 6 serotypes of *S. flexneri*, 18 serotypes of *S. boydii*, and 1 serotype of *S. sonnei*.

Anti – Microbial Studies of Isolate Flavonoids

By using a disc diffusion test, the study evaluated the grape seed extract against the prevalent peri-implantitis microflora present in craniofacial implants, encompassing clinical strains of *Candida parapsilosis*, *Klebsiella pneumoniae*, and *Staphylococcus aureus* in addition to reference strains of these bacteria. (Prashith *et al.*, 2014). There is no end to the battle between man and the microorganism that causes sickness. Man uses weapons, including naturally occurring chemicals, to destroy microorganisms. Plants are the store-house of chemicals which save man from diseases by the destruction of microbes. Many plants and their constituents have been investigated for their microbial activity. (Lwu *et al.*, 1984, Rao and Rao *et al.*, 1985). The popular methods of testing the anti-microbial activity of a compound are (i) Disc Diffusion Technique (Verma and Nobles *et al.*, 1975), (ii) Serial Dilution Technique (Gould, *et al.*, 1960) and (iii) Ditch plate Technique (Colins and Lyne, *et al.*, 1970).

MATERIALS AND METHODS**Preparation of Grape Seed Extract**

Grape peel and pulp were removed from the grape seeds. The seeds were dried for 72 hours at 50°C in a drying oven. Then, a kitchen mixer was used to grind the dried seeds into a fine powder. Each powder was extracted using 10 ml of ethanol and about 1 gm. Give it three days to rest at room temperature beaker covered tightly the ethanol not to be evaporated. The ethanol extracts of grape seed were then filtered by using Whatman No.1 filter paper, the



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supernatant discarded (dust) then the filtrate (ethanol) allow to ethanol evaporate through holes in covered paper. After complete evaporation of ethanol the Resveratrol deposited at the bottom of the beaker. The powder collect and used for further experiment of research work. (HuseyinEnginare *et al.*, 2007)

Shigella Flexneri

The strains of shigella flexneri were obtained from Dept. of Microbiology, Sri Ramachandra Medical College and Hospital, Chennai.

Media Growth Conditions

All the *shigella* species were routinely in Nutrient Agar (NA), Nutrient broth and *Shigella* agar (SA) at 37°C. The composition of NA, NB, and SA are as follows (Himedia, Mumbai, India). The medium was adjusted to PH =7.4 using 0.1N sodium hydroxide and sterilized by autoclaving at 15psi maintained constantly for 15 – 20 min. SA medium should not be autoclaved and hence was heated to dissolve the medium completely. When the temperature of the medium reached 50°C medium was then poured into culture plates (Scott, Duran, Germany)

Isolation of Erythrocytes

The Rizvi and Zaid method was used to isolate the erythrocytes (2005). After an overnight fast, healthy people's venous blood was drawn using EDTA as an anticoagulant.

Determination of Minimum Growth Inhibitory (MIC) Concentration

Grape seed extract's minimal inhibitory concentration (MIC) Mckance and Mandal, *et al.* claim that the microdilution method was used to perform the mic (1986). I) Nutrient Broth medium; II) Grape seed extract; and *Shigella flexneri* bacterial strain.

Antibacterial Activity of Grape Seed Extract

Grape seed extract's antibacterial activity was assessed using the agar well diffusion method, in accordance with (Hugo and Russel, *et al.*, (1977). Nutrient agar plates, Grape seed extract.

Contact Hemolysis

Contact hemolysis assay was done by the method of Blocker *et al.*, (1999). Reagents Nutrient broth, Grape seed extract, Human blood, Tris – saline.

Hydrogen Peroxide Induced Peroxidation of Erythrocytes

Reagents: 40M Hydrogen peroxide in a pH 7.4 phosphate buffer, 0.06M. Procedure In a total volume of 1 ml, the reaction mixture contained 0.2 ml of erythrocytes, 0.2 ml of 40 M hydrogen peroxide, and 25 g of grape seed extract. Hydrogen peroxide was added to start the reaction, which was then maintained at 37 °C for 30 minutes with periodic shaking every 10 minutes. The TBARS, conjugated dienes, and glutathione assays were conducted using the incubated mixtures.

Segregation of Experimental Groups

Group I- Only an erythrocyte

Group II -Containing erythrocytes incubated 750µg/ml of Grape seed extract.

Group III -Erythrocyte incubated with 0.5M hydrogen peroxide.

Group IV- Erythrocyte incubated with 750µg Grapeseed extract and 0.5 MH₂O₂.





Estimation of Lipid Peroxides

A modified version of the procedure described by was used to determine the level of TBARS in the lens homogenate Oh kawaet *al.*, (1979).

Estimation of Reduced Glutathione

An estimation of the amounts of reduced glutathione in erythrocytes was made using Ellmanet *al.*, (1959).

Assay of Superoxide Dismutase (SOD)

The method of Misra and colleagues was used to quantify the activity of total superoxide dismutase (SOD)Fridovichet *al.*, (1972).

Assay of Catalase

Spectrophotometric analysis was used to assess catalase using the Beer and Sizeret *al.*, (1952). **Reagent:**30 mm of hydrogen peroxide and 50 mm of phosphate buffer (7 pH)

RESULTS AND DISCUSSION

In addition to being used in alcohol-based tonics, Vitisviniferais recommended for spleen, subacute cases of enlarged liver, cough, and respiratory tract catarrh.(Wang, L, *et. al.*, 2014).European folk healers tried to treat skin and eye conditions with grapevine sap. (Monagas M *et.al.*, 2003).The leaves have also been used historically to treat hemorrhoids' pain, inflammation, and bleeding(R. Carpenter, M. N, *et. al.*, 2007).The antibacterial and antioxidantcharacteristics of grape seed extract have been studied. *Shigella*flexneri, a pathogen that causes diarrhea, was used as a test subject for antibacterial activity, while human RBC was used as a test subject for antioxidant activity.Fig(1)depicts how Grape Seed Extract works to fight microorganisms using agar well diffusion method carried out by the method of Hugo and Bussel (1997). In this method inhibition by grape seed extract was observed for *Shigella*Flexneri. The inhibition was found to be concentration dependent for both the extract and for the strain.The present studyFig(2). Shows the inhibitory effect of various antibiotics on *Shigella*flexneri by agar well diffusion method.Antibiotic sensitivity of *Shigella*flexneri wild type clinical isolate is given in the (Table -1) Clinical isolates of *Shigella*flexneri is found to be resistant to Ampicillin, and sulfosomidine. Fig (3) depicts (MIC) the technique's minimum inhibitory concentration test of Mekance and Kandal (1986) for the seed extract of VitisVinifera on *Shigella*flexneri. The MIC for *shigella*flexneri was found to be 1000 µg / ml.

Using the modified agar dilution millipore method, minimum inhibitory concentrations (MIC) and also minimum cidal concentrations (MCC) were calculated. The extract's ability to inhibit the growth of microorganisms was further examined after being mixed with propylene and polyethylene glycol.Fig (4) depicts the contact hemolysis and was carried out by the method of Block (1999) for the seed extract of VitisVinifera on *Shigella*flexneri. The percentage of hemolysis was found to be reduced in the presence of seed extract for *Shigella*flexneri, when compared to the control tube containing RBC and bacterial stain.Polyphenols have a strong affinity for proteins, and the inhibitory effect of polyphenols against microbes is due to their interaction with proteins present on the microbial surface (Rauhaet *al.*, 2000). Polyphenols suppresses the release of verotoxin in to the culture medium of EHEC cells (Sugita – Konishi *et al.*, 1999). Fig (5) A similar mechanism may be responsible for the observed result of lowering of contact hemolysis on treatment with grape seed extract.

Anti Oxidant Activity

Because of their effective defense systems, RBCs are resistant to oxidative damage under normal physiological circumstances. Antioxidant enzymes include glutathione reducatcs, catalase, superoxide dismutase, and glutathione peroxidase are abundant in RBCs. Yet, in the presence of heme-iron, polyunsaturated fatty acids, and oxygen, which



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may trigger the events that result in oxidative damage in red blood cells, RBCs are vulnerable to oxidative damage under situations of oxidative stress (Rajasekaran *et al.* 2004). It is known that the erythrocyte membrane makes up 1% of the entire cell weight. It comprises several membrane-bound enzymes that are essential for antioxidants, membrane-receptor complexes, ion transport, glycolysis, and the pentose phosphate cycle. It also has a great potential for plasticity and flexibility. The majority of certain areas of the membrane's inner (cytoplasmic) side are home to erythrocyte proteins, where they join together to form an actin and intermediate filament network that covers the entire cell volume. To keep the erythrocyte in its typical shape, this network creates a cytoskeleton (V. V. Moroz *et al.*, 2019).

Lipid Peroxides

Lipid peroxidation, glutathione SOD, and catalase in the organizations conducting experiments. In contrast to the group under control, erythrocytes treated with 0.5 M H₂O₂ had considerably higher levels of lipid peroxides. Erythrocytes exposed to 0.5 M H₂O₂ and grape seed extract showed reduced levels of peroxidation. The initial stage of oxidative damage in polyunsaturated fatty acids is conjugated diene creation, which may be evaluated by the rise in the absorbance ratio A₂₃₃/A₂₁₅. Conjugated diene formation can be used to monitor lipid peroxidation in erythrocyte membrane. TBARS is a measure of lipid peroxidation, and a rise in TBARS is a sign that there are more oxygen free radicals present. (Gabbianelli *et al.*, 2002). The current study's finding that TBARS and conjugated diene levels have increased suggests that H₂O₂ causes erythrocytes to experience oxidative stress. Resveratrol was discovered to block UVB-mediated enhanced lipid peroxidation, indicating that its antioxidant qualities may be responsible for resveratrol's ability to protect against the negative effects of UVB radiation. (AfaQ F, *et al.*, 1998). Several investigations have shown that resveratrol has antioxidant properties. (Martinez and Moreno, *et al.*, 2000; Olaset *et al.*, 1999). With its antioxidant capacity, resveratrol has been discovered to guard the kidney, heart, and brain against ischemic-reperfusion harm. (Bastia-netto *et al.*, 2000). According to the current study, the grape seed extract's components' claimed ability to scavenge free radicals is what caused the lipid peroxide in group IV to decrease. (Morales *et al.*, 2002).

GSH

When compared to control, the amount of glutathione in erythrocytes treated with H₂O₂ fell considerably. Erythrocytes treated with grape seed extract and H₂O₂ displayed elevated GSH levels. Group III had a significantly lower amount of GSH in comparison to group I. The most common intracellular thiol, glutathione, protects cells from hydroxyl radicals and singlet oxygen by scavenging them and acting as an antioxidant. The main component of the defense against free radicals is erythrocyte glutathione. Directly or by a method involving glutathione peroxidase, GSH detoxifies reactive oxygen species. (Fang *et al.*, 2002). In the current investigation, it was discovered that erythrocytes treated with H₂O₂ had lower GSH levels than controls. Addition of H₂O₂ causes an increase in oxidative stress in erythrocyte as seen by significantly decrease in GSH level and increase in lipid peroxides level. Addition of H₂O₂ activates glutathione peroxidase, an enzyme that uses glutathione as its substrate to remove H₂O₂ from the system (Fang *et al.*, 2002). Thus, increased utilization of glutathione due to addition of oxidant system cause a decrease in its level. By taking part as part of the cellular defense system against oxidative damage, GSH offers significant protection against oxidative injury. (Jo *et al.*, 2001). A crucial defense against the harmful effects of free radicals produced as a result of radiation on the blood, the lungs, and the brain. (Erden, *et al.*, 1992). A crucial defense against the harmful effects of free radicals produced as a result of radiation on the blood, the lungs, and the brain (Bhattatathiriet *et al.*, 1994). This protective action of the development by glutamyl cysteine synthetase, the rate-limiting enzyme for GSH synthesis in flavonoids, may account for GSH's defense against oxidative harm. GSH and vitamin E therapy reduced lipid peroxidation and restored GSH levels in pulmonary tissues (Myhrstadet *et al.*, 2002). Obtainable from grape seed extract. In blood samples from rats exposed to X-rays, a study found that GSE and vitamin E improved the antioxidant status and reduced the incidence of free radical-induced lipid peroxidation. These investigations show that GSE had a stronger antioxidant impact on animals when compared to vitamin E when rats were exposed to radiation (Myhrstadet *et al.*, 2002; Krishnamurthy, *et al.*, 1986). Jang and Pezzuto (1999). TPA therapy



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was also found to increase the expression of transforming growth factor- β 1 (TGF- β 1), COX-2, cyclooxygenase-1 (COX-1), and tumor necrosis factor. Resveratrol pre-treatment of mouse skin inhibited several of these TPA-induced effects in a dose-dependent manner. Myeloperoxidase, oxidized glutathione reductase as well as glutathione and H₂O₂ concentrations, were brought back to baseline levels, as was superoxide dismutase activity (Jang M, *et al.*, 1999). The observed effect in the present study may be due to the maintenance of the antioxidant (GSH) by resveratrol present in the grape seed extract and which otherwise could be space in scavenging these radicals.

Superoxide Dismutase

RBCs treated with H₂O₂ (Group III) were found to have considerably less SOD and Catalase activity than controls. The SOD and catalase activity of RBC treated with grape seed extract and H₂O₂ (Group IV) increased significantly. The increasing use of SOD in the adaptive response to oxidative stress for converting the superoxide anion to molecular oxygen and H₂O₂ is likely the cause of the lowered SOD activity (Kishimoto W, *et al.*, 1995). Treatment with grape seed extract negated the impact of oxidative stress caused by H₂O₂, as documented in numerous studies (Jany and pezzuto *et al.*, 1999).

SUMMARY

Clinical isolates of *shigella flexneri* was found to be resistant to many antibiotics showing the virulent nature of the microorganism. Growth is inhibited by ethanolic seed extract of Vitis Vinifera (Grape) and the minimum inhibition concentration for *shigella flexneri* was found to be 1000 μ g / ml. Treatment with ethanolic seed extract of Vitis Vinifera (Grape) reduces the ability of *shigella flexneri* to causes hemolysis, that is reduced the virulence of bacterial stain. Hence it may be used in the treatment of diarrhea caused by *shigella flexneri*. The lipid peroxidation was induced in human erythrocytes *in vitro* by hydrogen peroxide. In H₂O₂ induced peroxidation, there is an increase in TBARS and conjugated dienes level in erythrocytes with a decrease in glutathione, SOD and Catalase levels. Grape seed extract supplement reduced TBARS and conjugated dienes level and increased the level of GSH, SOD and Catalase. A good chemo preventative agent should have the following qualities: (a), minimal to no adverse effects on healthy, normal cells; (b), strong anti-tumor effectiveness; (c), oral bioavailability; (d), well-established mode of action; (e), affordable; and (f), approval by the general populace. One of the substances with numerous biological effects related to human disorders is grape seed extract. These findings indicate that ethanolic grape seed extract can stop diarrheal pathogen development. *Shigella flexneri*. Due to its antioxidant property it may have good future in preventing or mitigating various oxidative stresses associated diseases.

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Table -1 Clinical isolates of *Shigella flexneri*

No	ANTIBIOTIC	QUANTITY (MICRO GRAM)	RESISTANT/ SENSITIVE	ZERO DIAMETER (mm)
1	Gentamicin	G 10	sensitive	25
2	Chloramphenicol	C10	sensitive	23
3	Keramycin	Nr100	sensitive	23
4	Sulfosomidine	So300	Resistant	-
5	Ampicillin	A10	Resistant	-
6	Norflaxacin	Nr100	Sensitive	21



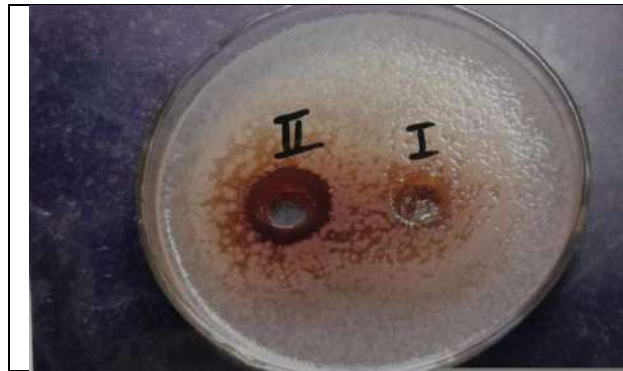
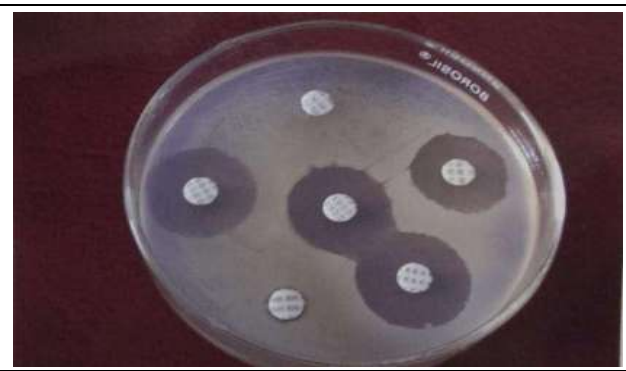
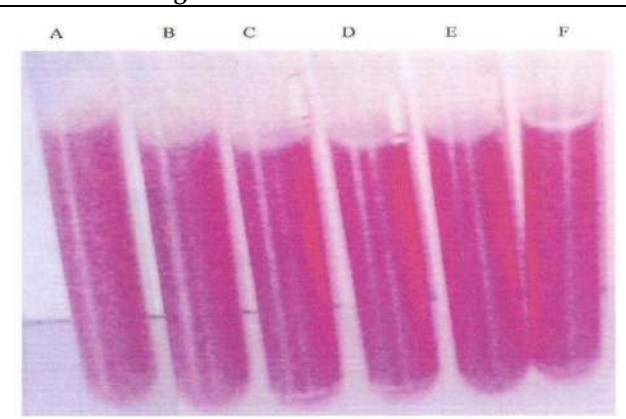
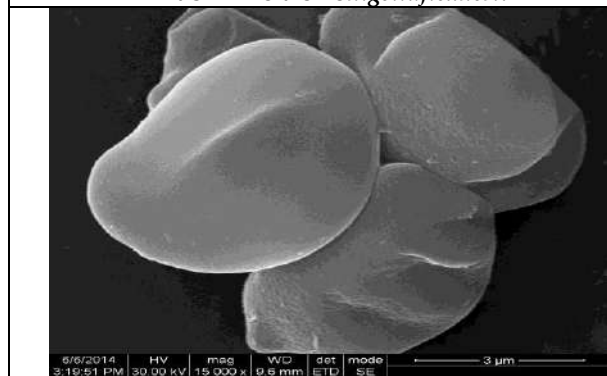
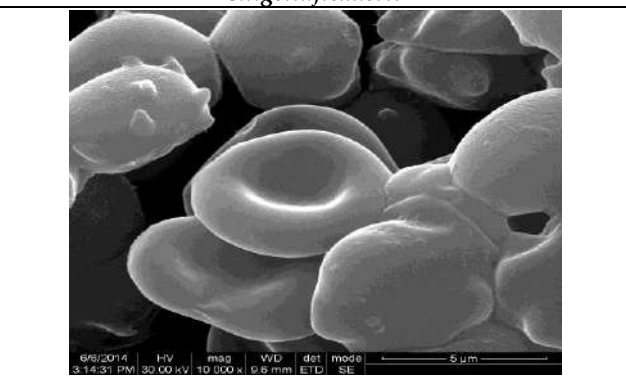


Fig 1: Antibacterial effect of Grape Seed Extract

Fig (2). Inhibitory effect antibiotics Resistant to Ampicillin, and sulfosomidine on *Shigella flexneri* by agar well Diffusion methodFig 3. Minimum Inhibitory Concentration test of *Vitis Vinifera* on *Shigella flexneri*.Fig 4. Contact hemolysis of *Vitis Vinifera* on *Shigella flexneri*.

Group-I Erythrocyte alone

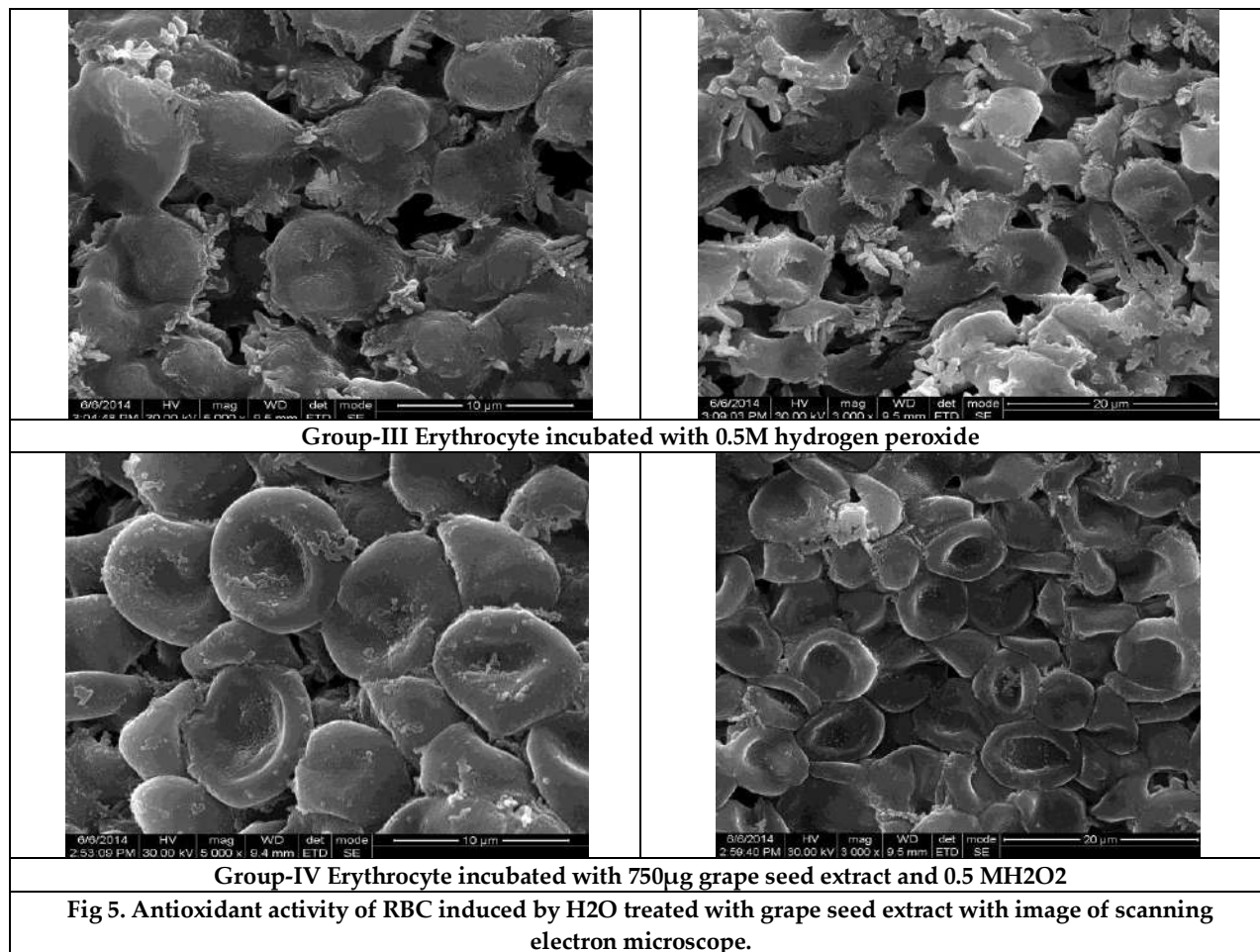


Group-II Erythrocyte incubated 750µg/ml of grape seed extract





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Regulation of Cryptocurrencies: Integrating Accountability and Innovation

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ABSTRACT

This study primarily focuses on the advantages and complexity of using block chain technology for cryptocurrencies and discusses the extensive regulatory challenges brought on by their development and expansion. Governments and regulatory agencies struggle with issues like investor protection and money laundering prevention as the Cryptocurrency ecosystem grows and changes. The diversity of cryptocurrencies and applications and the diverse regulatory standards employed by different Indian and other countries worldwide. In addition, this article explores significant regulatory challenges and offers viable solutions. The study's findings will be extensively used to comprehend the many kinds of available cryptocurrencies. Importance of Cryptocurrency regulation in striking a balance between innovation and accountability. Beyond cryptocurrencies, fostering a legislative climate that supports the growth of this new technology would enable the distribution of crypto-assets, which are a crucial economic stake for nations hoping to maintain their financially pleasant appearance.

Keywords: Cryptocurrency, Block chain, Regulatory, Technology in Finance, Challenges

INTRODUCTION

Advantages of using Blockchain Technologies for Cryptocurrencies

A sophisticated database system called blockchain technology enables transparent information sharing inside a company network. Data is kept in blocks that are chained together in a blockchain database. Due to the inability to delete or amend the chain without network consensus, the data remains chronologically consistent. In order to manage orders, payments, accounts, and other transactions, you can utilize blockchain technology to establish an



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unchangeable or immutable ledger. A common picture of these transactions is made consistent by the system's built-in features, which also stop unauthorized transaction submissions. A digital money known as a cryptocurrency was developed utilizing encryption methods. Cryptocurrencies can be used as both a medium of exchange and a virtual accounting system thanks to encryption technologies. It would help if you had a cryptocurrency wallet in order to use cryptocurrencies. These wallets might be PC or mobile device apps, or they could be cloud-based services. Wallets are the devices that you use to keep your encryption keys, which link your cryptocurrency to your identity and validate it.

Importance of Block Chain Technology

There are various obstacles when it comes to capturing financial transactions with traditional database technologies. Take the sale of a property, for example. Ownership of the property passes to the buyer once payment is exchanged. Both the seller and the buyer can independently record the financial transactions, but neither source can be relied upon. Both the buyer and the seller might easily argue that they have paid the money even though they have not received it or that they have not received it at all. To steer clear of any possible legal problems, transactions must be supervised and verified by a reliable third party. In addition to making the transaction more difficult, the existence of this central authority adds one more point of risk. If there was a breach in the central database, both sides might be affected.

Blockchain reduces these problems by establishing a decentralized, impenetrable transaction record system. Within the real estate transaction context, blockchain generates a single ledger for both the vendor and the buyer. Every transaction that is automatically updated in real-time in both ledgers requires approval from both parties. Any manipulation of past transactions will taint the entire ledger. These characteristics of blockchain technology have made it useful across a range of industries, including the production of virtual currencies like Bitcoin. Blockchain is a particularly groundbreaking and promising technology because it provides scalable transparency, eliminates fraud, and lowers security threats. Blockchain technology, made popular by its connection to cryptocurrencies and NFTs, is now a management tool used by all international sectors. Blockchain technology is currently revolutionizing gaming, safeguarding healthcare data, bringing transparency to the food supply chain, and generally altering the way we handle ownership and data on a big scale.

Use of blockchain in cryptocurrency

Currently, the most popular application of this technology is blockchain for money. Blockchain facilitates the safe processing and recording of transactions for popular cryptocurrency coins like Ethereum and Bitcoin. Transparency, identity protection, and financial data security for cryptocurrency buyers and sellers are all made feasible by this technology. However, no public or private organization is supporting cryptocurrencies. It has been challenging to argue their legal standing in various financial jurisdictions across the globe as a result. It does not help that the majority of cryptocurrencies have operated outside of the current banking system.

Advantages and Disadvantages of Cryptocurrency

The goal of the introduction of cryptocurrencies was to transform the financial system. However, as with any revolution, there are costs and benefits. The theoretical ideal of a decentralized system with cryptocurrencies and its actual execution differ greatly at this point in the development of cryptocurrencies.

- Eliminates isolated points of failure
- It is simpler to move money between parties,
- Eliminates intermediaries,
- Generates returns, and
- Streamlines remittances.

Cryptocurrencies represent a new financial paradigm. They pledge to speed up and reduce the cost of the current financial architecture. Furthermore, their architecture and technology decentralize the current monetary systems and enable value and money exchange between transacting parties without the need for intermediaries like banks. Asset



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tracking and transaction recording in a corporate network are made easier by blockchain, an immutable shared ledger.

Issues pertaining to the utilization of Bitcoin and blockchain technologies

To hide their true identities, thieves use a variety of tools and services that route money through multiple addresses or companies. The assets are subsequently transferred to a destination location or an exchange for liquidation from a source that appears to be authentic. It is challenging to link money laundered through this procedure to illegal activity. On the blockchain, popular techniques are employed for money laundering.

1. Services that function inside one or more exchanges fall under the large category of nested services. In order to take advantage of trading opportunities, these services use addresses hosted by the exchanges to access the exchanges' liquidity. Certain exchanges have lax compliance requirements for nested services, which makes it possible for dishonest people to use them as a means of money laundering.

2. Among bitcoin money launderers, gambling platforms are well-liked. Money is deposited into accounts that are either recognizable or anonymous on the platform. They are frequently used in conjunction with affiliates to either cash out or place bets. The gambling account may be granted legal status once the funds have been disbursed. The "Virtual Assets Red Flag of Money Laundering and Terrorist Financing" report published in September 2020 by the Financial Action Task Force (FATF) includes information about gambling services.

3. To improve anonymity, mixers combine digital assets from many addresses before releasing them sporadically to new wallets or destination addresses. Before money is moved to reputable companies or significant exchanges, they are frequently employed to hide the trail of money.

4. Fiat exchanges, which convert cryptocurrencies into fiat money, can be mainstream, peer-to-peer (P2P), or non-compliant (exchanges that do not follow the rules or are exempt from restrictions). Conventional financial investigative techniques need to be used after monetary exchanges have occurred.

5. Service providers with their headquarters located in high-risk jurisdictions are those whose AML or CFT regulations have been found to have strategic shortcomings. The "block list" and "grey list," as they are colloquially known, are lists of nations maintained by the Financial Action Task Force (FATF) that have inadequate mechanisms in place to prevent money laundering and terrorism financing (AML/CFT). Some other difficulties that the cryptocurrency faces are as follows:

- Due to their extraordinary volatility, the quick expansion and growing popularity of cryptocurrency assets potentially present risks to financial stability.
- Compared to currency rates, stocks, or commodities, these are significantly more erratic. Instability is being introduced into the environment by this volatility.
- The cryptocurrency ecosystem presents various challenges, such as operational and financial integrity concerns from cryptocurrency asset providers,
- investor protection risks for cryptocurrency assets and
- Inadequate reserves and disclosure for certain stablecoins.

Regulatory Obstacles to the Development and Growth of Cryptocurrencies

Regulators and legislators are hastily drafting, approving, and changing crypto-asset laws all around the world. Many significant modifications to the regulatory environment are being considered by over three-quarters of the nations assessed in the Atlantic Council's Cryptocurrency Regulation Tracker. Globally, one of India's main priorities during its G20 presidency is the regulation of crypto assets. In addition, the legal impact of FTX's collapse is still very much ongoing here in the United States. Binance and Coinbase, two significant cryptocurrency exchanges and competitors of FTX were sued earlier this week by the US Securities and Exchange Commission (SEC). Recently, decision-makers convened in Washington, DC, for the IMF and World Bank Spring Meetings, underscoring the necessity of international advancement in the regulation of cryptocurrency assets. Global regulatory development was on the agenda for the G20 finance ministers and central bank governors, as well as the International Monetary and Financial Committee. The future of crypto-assets was the subject of one session wherein crypto rules were deliberated. The meetings clarified two points. Firstly, there is an obvious need for strong, internationally synchronized crypto rules. Furthermore, second, reaching that objective will provide significant obstacles for



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policymakers. Regulations pertaining to consumer protection are less developed than others. Investors who engage in cryptocurrency markets run a significant risk. Theft is becoming more frequent. Volatility is a key characteristic of cryptocurrency markets, frequently driven by speculation. Make intelligent investing harder with misinformation and misleading advertising. We discovered that, despite the risks to consumers, barely one-third of the countries under study had laws protecting them. While laws are frequently unproven or unclear, participants in the cryptocurrency market may be covered by legal protections in other nations.

Cryptocurrency assets' challenges

- Owing to their extraordinary volatility, the fast expansion and growing popularity of cryptocurrency assets potentially present threats to financial stability.
- Exchange rates, commodities, and stocks are less volatile than these. This volatility is introducing an ecosystem of instability.
- The threats to investor protection for crypto-assets,
- Operational and financial integrity from crypto asset providers and inadequate reserves
- Disclosure for certain stablecoins is among the challenges presented by the crypto ecosystem.

Regulation of cryptocurrencies is crucial for achieving a balance between responsibility and innovation because:

- Investor Protection: Regulations help safeguard the interests of investors by ensuring transparency, disclosure of information, and preventing fraudulent activities.
- Mitigating Risks: Regulations address risks associated with cryptocurrencies, such as money laundering, terrorist financing, and fraud, by implementing measures like KYC and AML requirements.
- Market Integrity: Regulations promote fair and orderly markets by preventing market manipulation, insider trading, and other unethical practices.
- Consumer Confidence: Clear regulations enhance consumer confidence in cryptocurrencies, encouraging wider adoption and participation in the market.
- Innovation with Responsibility: Regulations provide a framework for responsible innovation, encouraging the development of new technologies and business models while ensuring compliance with legal and ethical standards.
- Financial Stability: By monitoring and regulating cryptocurrency activities, regulators can help maintain the financial system's stability and protect against systemic risks.
- Global Standards: Regulations help establish consistent global standards for cryptocurrency operations, facilitating cross-border transactions and fostering international cooperation.
- Compliance and Accountability: Regulatory frameworks hold cryptocurrency businesses accountable for their actions, ensuring they operate within legal boundaries and meet certain standards of conduct.
- Preventing Illicit Activities: Regulations help deter the use of cryptocurrencies for illicit purposes, such as money laundering, tax evasion, and funding illegal activities.
- Evolving Landscape: Regulations must adapt to the evolving nature of cryptocurrencies and technological advancements to balance innovation and accountability.

Cryptocurrencies have come a long way from being an ordinary means of exchange to disrupting the traditional finance industry. Crypto users can now participate in old and new financial activities, such as trading and lending services, decentralized finance (DeFi), and NFTs. The new cryptocurrency, Big Eyes (BIG), intends to tap into this disruptive nature of cryptocurrencies. Thus, it could join crypto giants like Binance Coin (BNB) and Compound (COMP) to offer users versatile features in the crypto space.

Big Eyes: The Upcoming Versatile Meme Coin: Big Eyes (BIG) is the latest entrant in the meme coin family. However, it intends to impress the market by offering wealth-generating opportunities to users through its diverse ecosystem.

The Multifunctional Binance Coin: Binance Coin (BNB) drives the BNB Chain ecosystem. It was created as a utility token for discounted trading. However, it has expanded to include numerous applications, including smart contracts, transaction fee payment, travel, entertainment, and general digital finance services.





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Compound: The Secured Lending Cryptocurrency: Compound (COMP) is a DeFi protocol strictly for crypto lending. It allows users to earn interest on their cryptocurrencies by depositing them into one of several lending pools supported by the platform.

Applications of Cryptocurrency: Currently, private investors can access cryptocurrency assets the simplest. Investors can buy, sell, and trade cryptocurrencies through a number of brokerage firms in addition to stocks, mutual funds, and other investment options.

The majority of people view cryptocurrency trading as a way to generate passive income, but some people view it as an alternative investment to more traditional forms of investing. Every day, the market for cryptocurrencies is growing in size and attracting an increasing number of investors. Cryptocurrency platforms have created apps as a result.

Pionex: One of the greatest choices for Bitcoin applications for investors seeking automated trading is Pionex. Auto trading is feasible with this cross-platform program's 16 free built-in trading bots.

Webull: If you are looking to risk only a small amount of money or are on a limited budget, Webull can be one of the best cryptocurrency applications for this purpose. Regarding fees, Webull charges merely a spread for all of its marketplaces. We found that there was not much competition in the minimum spread for cryptocurrency transactions, which is 1%.

Coin base: This is possibly one of the best cryptocurrency programs for beginners. It is the next alternative. When utilizing the app to purchase Bitcoin with a debit or credit card, Coin Base's basic trading fees will be heavily taxed at 3.99 percent. The user-friendly user interface comes after the program.

Binance: One of the greatest applications for cryptocurrencies is Binance, which provides the essential features of investing, staking, sending, and receiving money. Trading pairings between more than 500 coins and tokens are possible. For the same transaction, users from other nations may have to pay up to 4%. The Binance app is available for free download on both iOS and Android handsets.

Gemini: Gemini might be the best Bitcoin app for an experienced trader who makes significant trading investments on a regular basis. This highly regarded exchange is heavily regulated in the United States and is one of the few cryptocurrency platforms licensed by the New York State Department of Financial Services.

Aqru: Aqru differs from other cryptocurrency programs in that it is not centered on trading services. Conversely, Aqru is one of the best sites for generating interest in cryptocurrencies. A very generous APY of 7% will be awarded to investors who deposit their Ethereum or Bitcoin tokens into the Aqru app.

Due to its popularity among those wishing to use cryptocurrency as an alternative form of capital, it has grown significantly in the last several years. Cryptocurrency assets are viewed as high-risk investments by millennials despite their widespread use. However, those who have realized its potential are aware of its ability to change the course of history.

Act to Prevent Money Laundering as it Relates to the Cryptocurrency Ecosystem.

A notification was released on March 7, 2003, and went into effect on July 1, 2005, in accordance with the terms of the PMLA Act 2002. including other regulated companies, including banks, virtual digital asset (VDA) service providers are subject to reporting requirements and KYC guidelines, and the Union Minister of Finance to payment system operators. The PMLA Act covers the following: trading virtual digital assets (VDAs) for fiat money; transferring VDAs; exchanging VDAs in different formats; keeping and managing VDAs; and offering financial services associated with the offers and sales of VDAs.

Before using Bitcoin, people or organizations must purchase a digital wallet to hold their public and private keys. These keys are needed to transfer and receive cryptocurrency as well as to validate blockchain transactions. Thanks to the notification, cryptocurrency exchanges are now considered "reporting entities" for PMLA Section 2(a).

The following operations pertaining to cryptocurrencies have been included under the purview of PMLA:

- VD/FIAT currency exchange
- The interchange of one or more virtual digital asset types
- The exchange of virtual digital assets.
- The management or preservation of virtual digital assets or tools that allow for their control.



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Taking part in the offer and sale of a virtual digital asset by an issuer and offering financial services in connection with it. Stated differently, transactions involving the exchange of cryptocurrency for fiat money, the transfer of VDAs between two individuals or legal entities, and the trading of cryptocurrency for cryptocurrency are all subject to the restrictions of the Money Laundering Act. Crypto exchanges are now considered "reporting entities" under Section 2(a) of the PMLA as a result of the notification. According to the definition of a reporting entity in this Section, it is "a banking company, financial institution, intermediary or a person carrying on a designated business or profession," which suggests that all entities that deal with cryptocurrency, NFTs, and other VDAs get included. A prevalent motif throughout most cybercrimes is money laundering. Malevolent actors take advantage of anonymity through the use of blockchain technology to conceal the origins of illegal monies, turn them into cash, and then transfer those funds into the established banking system.

The legal standing of cryptocurrencies in India

- Despite including a cryptocurrency tax in the Union Budget of the previous year, the government chose not to move further with drafting legislation.
- India imposed an income tax of thirty percent on Bitcoin earnings in April of 2022.
- July 2022 saw the implementation of regulations pertaining to the deduction of 1 percent tax at source on cryptocurrencies.
- The Supreme Court had earlier struck aside a prohibition that the RBI had recommended.
- Noting the RBI's worries, the Finance Minister informed Parliament in July 2022 that international cooperation would be required for any law regulating cryptocurrencies or prohibiting them.

Prospects for the expansion of the cryptocurrency system:

- Technological progress is bringing in a new era that makes financial services and payments more affordable, quicker, and available.
- It also enables these services to move quickly across borders.
- Stablecoins derived from bank deposits can provide quick access to a range of financial goods and facilitate instant currency conversion.
- Decentralized finance has the potential to serve as a foundation for financial services that are more inventive, inclusive, and transparent.

CONCLUSION

Leaders of the G20 will now consider how nations might work together to manage digital assets more effectively. "an official said. 'India has brought the regulation of these assets on the agenda of G20, whose role gained greater importance amid global financial sector woes in 1999 and 2008,' the official added. 'Crypto challenge' "A single country cannot regulate cryptocurrencies effectively. We have discussed the building blocks for such regulation. A road map arrived at in consultation with the International Monetary Fund, whom we roped in to advise on macroeconomic implications of these assets, and the Financial Stability Board," The representative continued by pointing out that India has drawn attention to the unique hazards that these virtual assets pose to developing and emerging regions. A comprehensive approach should be taken when regulating cryptocurrencies. Finding the right mix between responsibility and creativity is crucial. Effective regulation may promote a safe and secure environment for businesses and cryptocurrency consumers while advancing blockchain technology. Policymakers must remain flexible and forward-thinking as the cryptocurrency environment changes to ensure their regulatory frameworks keep up with this fast-moving and revolutionary sector. Finding this balance is difficult, but it must be accomplished if cryptocurrencies are to reach their full potential in the contemporary financial ecosystem.

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Impediments to Environmental Education in the Context of Indian Education System

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ABSTRACT

In today's global context, addressing environmental concerns has transcended national boundaries, making it a paramount issue not just in India but across the world. Our awareness of pressing environmental challenges such as pollution, soil erosion, and ozone layer depletion is extensive, yet there exists a critical gap in understanding the hurdles within the realm of education itself, hindering the awakening of citizens to the imperative of planetary care. While we acknowledge the pivotal role education plays in mitigating environmental issues, we often overlook the barriers that impede its effectiveness. The prevailing approach focuses on sensitizing citizens to environmental protection through education, yet lacks comprehensive efforts in refining educational strategies and frameworks to tackle these challenges head-on. The pressing need for transformative Environmental Education and active engagement in environmental issues is undeniable. Education's purpose extends beyond imparting mathematical skills or historical facts; it is fundamentally about equipping learners, educators, and stakeholders to safeguard our planet, fostering a conducive environment for all living and non-living entities. This paper delves into the intricate challenges within the field of environmental education in India, aiming to identify these obstacles as a precursor to devising effective strategies. By understanding these challenges, we pave the way for informed and strategic interventions that can sensitize generations to the existing and potential environmental threats, thereby nurturing a collective responsibility towards our planet's well-being.

Keywords: Environmental Education, Protection, Planning, Provisions, Stakeholders, Challenges, Sensitize, etc.





INTRODUCTION

In the intricate tapestry of life, we are sustained by the benevolence of Mother Nature. Yet, in our relentless pursuit of sustenance, we have grown heedless, neglecting the very abode we inhabit and the nurturing embrace of our motherly provider. Enthralled by the allure of progress, globalization, and modernity, we have unwittingly become blind to the gradual erosion of our natural surroundings. The degradation of our environment has reached such alarming proportions that it demands urgent and unwavering attention, imploring us to step forward as stewards of our planet's well-being. To unravel the complexities of this degradation, we must delve into its roots, confronting challenges spawned by industrialization, burgeoning populations, pollution, poverty, and an insatiable appetite for opulence. Among these challenges lies the failure of education to instill a deep-seated environmental consciousness within our society, imperilling the delicate equilibrium between humanity and the ecosystems we inhabit. Recognizing these critical issues and the imperative to address them, the paradigm of Environmental Education for sustainable development has emerged as a beacon of hope. This transformative approach seeks to empower learners and stakeholders, urging them to safeguard, preserve, and cherish our natural heritage across all echelons of society. This noble initiative not only endeavours to salvage our environment from imminent peril but also endeavours to awaken our society, rousing it from its eco-indifferent slumber. At the academic forefront, Environmental Education has been woven into the fabric of learning, mandated as a compulsory subject at the undergraduate level by the esteemed University Grants Commission. This mandate extends its benevolent reach to students of Arts, Science, and Commerce, while at the school level, the National Council of Educational Research and Training and State Education Councils of almost all states in India have embraced this essential subject. Curriculum designers, too, have meticulously integrated environmental concerns at every educational tier. Despite these commendable strides, the collective endeavour to nurture an environment-conscious populace encounters numerous stumbling blocks. These obstacles, akin to unseen threads, weave a tapestry of hindrances that thwart our nation's ability to embrace environmental stewardship with the diligence it deserves. Thus, it becomes our collective imperative to diagnose, dissect, and dismantle these barriers, liberating education from the constraints that shackle its potential to address environmental challenges comprehensively and effectively.

Content

Presently, the educational content within Indian Environmental Education falls short of being truly comprehensive and enlightening for students. Those entrusted with framing the curriculum must not confine their focus solely to the theoretical facets of the environment; instead, they should craft content that offers abundant opportunities for students to immerse themselves in exploring the environment firsthand. This immersive approach aims to awaken an awareness of the intricate interconnections between humans and their environment, shedding light on the detrimental actions of humans that degrade it, and elucidating the responsibilities we bear in its preservation. Siddiqui & Khan (2015) have astutely advocated for content that bridges the gap between classroom knowledge and the tangible world, emphasizing relevance to learners' lives. Such content should grapple with issues that hold paramount significance for society while equipping learners with vital skills that foster lifelong learning. Crucially, this educational approach advocates for firsthand experiences, recognizing their pivotal role in cultivating a genuine understanding. By directly encountering environmental challenges, students can develop an innate sense of empathy and concern. These experiences serve as catalysts, compelling students to contemplate innovative solutions for the betterment of the environment and the lives reliant upon it. Therefore, the content of environmental education must not only be practical but also imbued with an encouraging spirit. It should inspire future generations to embark on earnest initiatives, instilling in them the zeal to improve the degraded state of our environment, thereby ensuring a sustainable legacy for all.

Allocation of Time

The time allocated by educators and learners to familiarize themselves with environmental issues remains woefully insufficient to grasp the depth of environmental challenges and their potential solutions. Environmental education,



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often relegated to the status of an additional, substitutive, or less prioritized subject, fails to receive the attention it truly merits. It is perceived merely as an adornment, incapable of fulfilling the essential objectives of other disciplines. Attempting to beautify a dishevelled or charred home seems futile when the core issues are overlooked. A prevailing pattern observed in educational institutions is the scant attention dedicated to environmental education, typically confined to once a week or biweekly sessions. The institution's timetable, a reflection of its priorities, further underscores the lack of seriousness attached to environmental education. These sessions are often scheduled after lunch or slotted once or twice a week, underscoring the prevailing apathy towards recognizing the urgency of environmental education.

Absence of Environmental Initiatives Organization

In light of the previously discussed inadequacies regarding time allocation for environmental initiatives and the burden of existing curricular demands, it becomes evident that educational institutions seldom prioritize the organization of eco-friendly activities. Infrequent glimpses of environmental engagement occur, such as sporadic tree plantation or cleanliness drives carried out annually, often coinciding with occasions like World Environment Day or as part of NSS (National Service Scheme) initiatives. Sadly, these events serve as rare opportunities for learners to genuinely perceive environmental issues and actively engage with them. Environmental awareness initiatives, limited to activities like tree planting and community cleanups, overlook a plethora of meaningful endeavors. A wealth of untapped potential lies in activities such as educational field trips, invigorating debates on environmental concerns and the human actions underlying them, stimulating slogan-writing competitions, compelling awareness rallies, and insightful symposiums addressing multifaceted environmental issues. The vast spectrum of possibilities remains largely unexplored, leaving a significant void in learners' understanding and active participation in the realm of environmental conservation.

Diminished Scholastic Significance

A prevailing trend underscores the perception of Environmental Education as a subject or discipline possessing diminished academic merit. This devaluation extends to environmental professions, often regarded as inconsequential or lacking in significance. Remarkably scarce are instances where schools incorporate Environmental Education into their daily curriculum, relegating it to the periphery in comparison to subjects like mathematics, English, or Science. Furthermore, colleges and universities seldom elevate Environmental Education to the status of an honors subject or a viable career choice. The scarcity of educational institutions embracing Environmental Education as a fundamental discipline illustrates a glaring gap in awareness, not only among learners but also within the intellectual circles and the nation at large, concerning the paramount importance of environmental knowledge. Siddiqui & Khan (2015) emphasized this very issue, shedding light on students' indifference towards Environmental Education, rooted in the misconception of its negligible academic worth. Bridging this gap necessitates a transformative shift in societal perspectives, acknowledging the profound significance of environmental education in shaping informed and responsible future generations.

Educational Overload

Learners find themselves inundated with a deluge of subjects, homework assignments, and an array of practical tasks, projects, and dissertations, leaving them with scant time to delve into the realm of environmental knowledge and its complexities. Without a solid understanding of environmental issues, the prospects of formulating innovative solutions dim, and the possibility of adopting corrective lifestyles to prevent environmental degradation remains elusive. The onus falls heavily on curriculum developers to alleviate the weight of other subjects that often receive disproportionate emphasis. The Central Board of Secondary Education advocates for a minimum of two periods per week dedicated to Environmental Education, with student performance meticulously recorded. However, the stark reality is that students preparing for their board examinations perceive Environmental Education and its associated outdoor activities as an unwelcome burden, an unnecessary encumbrance. This burden doesn't merely weigh on the shoulders of students but also burdens teachers and parents, causing undue stress. Striking a balance in the educational curriculum is imperative; overemphasis on certain subjects should be mitigated, allowing essential



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subjects like Environmental Education to receive the attention they deserve, thereby fostering a harmonious educational experience.

Educators' Limited Environmental Insight

Upon scrutinizing the syllabi of B.Ed., D.El.Ed., and comparable teacher training programs, a conspicuous absence emerges regarding the incorporation of environmental awareness. These programs notably lack discussions on environmental issues and fail to equip trainees with the essential knowledge and skills needed to imbue their future learners with environmental sensitivity. Crucial subjects such as biological diversity, pollution control, waste management, and the conservation of forests and wildlife remain conspicuously absent from the training curriculum. Integrating practical tools for field learning becomes pivotal, enabling teachers to comprehend the intricate facets of nature and subsequently share this knowledge with their students. In-service teachers, too, require ongoing exposure to environmental issues, tailored to their specific needs. Recognizing that only educators awakened to environmental concerns can effectively nurture a sense of environmental responsibility among their students, it becomes imperative to bridge this knowledge gap and empower teachers as effective catalysts for environmental awareness.

Deficient Entry Requirements for Environmental Education Instructors

Acareful examination of the prerequisites for teachers instructing Environmental Education reveals a glaring oversight. Individuals possessing postgraduate degrees in Science are often appointed to teach Environmental Education in schools. However, the genuine criterion mandates a specialized degree in Environmental Science – a postgraduate qualification complemented by B.Ed. and STET certifications – for teaching students in grades 6-10, and D.El.Ed. qualifications for other levels. Despite the explicit eligibility criteria outlined for Environmental Science teachers, the educational system inexplicably opts for candidates with mere B.Sc. degrees, even if they struggle to articulate a basic understanding of the term "Environment." This laxity in recruitment standards underscores the urgent need for the education system to meticulously select qualified educators, assistant professors, and teaching professionals capable of imparting environmental knowledge effectively.

Absence of Career Guidance

Little do we realize the myriad career prospects within the realm of Environmental Education. Individuals can emerge as environmental advisors for esteemed corporations specializing in Environmental Impact Assessment. Moreover, avenues within international organizations like UNDP, UNEP, WWF, CEE, IUCN, BNHS, WTI, etc., become accessible with a pursuit in Environmental Education as a profession. The spectrum of career choices extends to environmental activism, agricultural technology, air quality inspection, animal services, and beyond. It is imperative to shed light on these diverse professional opportunities available to those venturing into Environmental Science as a subject or career path.

Scarcity of Support from Organizations

The responsibility of education transcends the realms of the government, teachers, and parents; every societal stakeholder must contribute equally. To educate future generations about environmental preservation, conservation, and sustainability, society at large must actively engage. Environmentalists and organizations devoted to environmental causes can dedicate their time to share experiences and insights, fostering a collective understanding. Financial support from these entities can facilitate educational institutions in organizing workshops focused on environmental awareness for both teachers and students. Collaborative initiatives, such as cleanliness drives, involving community workers and volunteers can be orchestrated in schools and colleges. Furthermore, national bodies like the National Council of Science, Technology and Communication and the National Institute of Science Communication and Information Resources can orchestrate campaigns and programs addressing environmental awareness in educational institutions. By encouraging learners, teachers, and the entire nation to work collaboratively, these initiatives can significantly contribute to the enhancement of our environment. In addition, programs like GLOBE, which stands for Global Learning and Observations to Benefit the Environment, present invaluable opportunities for learners to engage in data collection and scientific processes. This active involvement



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allows them to meaningfully contribute to our comprehension of Earth systems and the global environment. Recognizing that the environment is the shared abode of not only teachers and students but all living beings, it becomes a collective responsibility to support educational institutions in nurturing environmentally conscious learners. Every individual must actively bolster these educational endeavours, enabling learners in all their environmental initiatives.

CONCLUSION

Given our collective awareness that existence is inseparable from our abode and the environment that sustains us, urgent measures are imperative to rejuvenate our environment, teetering on the precipice of severe degradation. The imperative to rectify our eco-unfriendly practices, the root cause of pollution, global warming, and soil erosion, cannot be overstated. While education undeniably assumes a pivotal role in sensitizing humanity toward eco-friendly behaviours, overcoming the challenges outlined above demands concerted efforts from every individual and stakeholder in society. Immediate action, particularly within the realm of Environmental Education, is indispensable. This necessitates refining educational content, dedicating substantial time to environmental concerns, elevating Environmental Education to the status of a disciplined career path, and infusing environmental awareness and training into teacher education programs. Additionally, robust organizational backing is essential to achieve the objectives of Environmental Education. Rigorous criteria for the eligibility of teaching professionals involved in environmental education are equally vital. By upholding these standards, we can pave the way for a sustainable future, where both humans and the environment coexist harmoniously

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Fish Collagen for Wound Management: Extraction, Sources and Applications

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ABSTRACT

This review provides an overview of fish collagen production for pharmaceutical and medical applications, focusing on extraction and characterization techniques. Mammalian collagen derived from sources such as cattle and pigs is widely used but faces limitations due to religious and ethical concerns and the risk of infectious diseases. Fish collagen, sourced from by-products such as the head, fins, skin, and viscera, offers a potential solution. Its ease of extraction, low molecular weight, and lack of animal-related risks make it an attractive alternative. Additionally, fish collagen exhibits biodegradability, biocompatibility, and antigenicity. The review aims to shed light on fish collagen's composition, characteristics, and structure, as well as its potential for wound healing in biomedical settings.

Keywords: Fish collagen, collagen Extraction, Wound Healing, Collagen Structure.



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INTRODUCTION

In the extracellular matrix of the several connective tissues in the body, including the skin, bones, ligaments, tendons, and cartilage collagen is the most prevalent structural protein [1,2]. Collagen's main biomedical uses include biomaterials, particularly as carriers for drugs and genes, tissue engineering, absorbable surgical sutures, osteogenic and bone filling materials, hemostatic agents, immobilisation of therapeutic enzymes, and burn/wound cover dressings [3–8]. For tissue growth and structural support, collagen is crucial. It guarantees the tensile strength, hardness, and elasticity of tissues for motility, regeneration, and maintenance as structural support through mechanochemical transduction processes [2, 5]. Additionally, it encourages the development of fibroblasts, a fibrous network of cells that serves as a scaffold for the expansion of new cells into tissues with different physiological functions, such as cartilages, bones, tendons, and skin [5, 6]. By inhibiting pathogen absorption and dissemination, especially of dangerous microbes, collagen has a special ability to protect and speed up wound healing [7]. Collagens derived from bovine, pig, and poultry sources are the most commonly used and commercially viable in the production of collagen products [4]. However, the use of bovine and pig collagens is not acceptable by some religious and ethnic groups. There are also infectious and contagious diseases associated with pigs and cattle, such as Bovine Spongiform Encephalopathy (BSE). Therefore, the applications of animal-derived collagen are frequently contentious and limited [1, 2]. Due to their low molecular weight and small particle size, marine collagens like fish skin, bone, cartilage, and scales—which come from both marine vertebrates and invertebrates—are more bioavailable than porcine or bovine collagen and have a higher absorption capability (up to 1.5 times more efficiently into the body) [8] and faster bloodstream circulation [9]. In terms of amino acid content and biocompatibility, marine-based collagens are comparable to traditional bovine and pig collagen [10]. Fishbone, scales, and skins, which are consumed everyday in many regions of the world and produce a significant quantity of waste (between 50% and 70% of the original raw materials, which is generated from fish), can be used to make fish collagen.[11]

Collagen is a key element in the healing of wounds; it serves as a natural structural framework or substrate for the development of new tissue and is involved in all stages of wound healing, including homeostasis, inflammation, proliferation, and remodeling [8]. Endogenous collagen, which is composed of three lengthy chains of amino acids shaped like helicoids, is the type of collagen produced by living things. Collagen is made up of polypeptide chains with the repeating sequence (GlyXY)_n, where X and Y can be any amino acid, but are most frequently proline and hydroxyproline (Hyp) [9,10]. As people age, are exposed to ultraviolet light, and use cigarettes, collagen begins to break down. The breakdown of collagen causes wrinkles and aging. Therefore, it is crucial to find alternative sources of collagen for regenerative tissue applications [11,12].

Collagen Molecular Structure

In vertebrate tissues, there are 28–29 different types of collagen, each of which is encoded by at least 45 different genes. These collagens have different structures, sequences, functions, and molecular characteristics. A 300nm long by 1.5–2.0nm wide single collagen molecule cannot manufacture as much collagen as a multicollagen molecule [14]. Basic amino acids make up collagen. "Tropocollagen" sub unit [15]. The enormous structural diversity within the collagen family allows for the classification of members into various groups. Additionally, type I is present in connective tissues like skin, bone, and tendons, type II is present in cartilage tissue, type III is present in muscle tissue, and other kinds are present but only in very minute quantities and are primarily organ-specific [15]. All twenty amino acids are present in collagen. Mammalian collagen contains a lot of imino acids, including proline and hydroxyproline, hydroxylysine, and hydroxyproline [16]. The most common kind of collagen found in mammals and fish is type I collagen, a fibrous collagen with a triple helical structure [17,18]. Furthermore, environmental factors like temperature have an impact on the makeup of amino acids. Collagen extracted from warm-water fish species has been shown to have higher thermal stability than collagen derived from cold-water fish species [16]. There are also reports of variations in thermal stability between warm-blooded mammals and cold-blooded fish. This may be related to the amount or concentration of the amino acid hydroxyproline, which helped to stabilise the collagen's helix structure by participating in interchain hydrogen bonding. The content of hydroxyproline and its function both





affect the thermal stability of fish collagen [17]. Therefore, compared to collagen generated by cold-water fish like cod, collagen produced by fish grown in warmer temperatures, such as tilapia, will have more imino acids (proline and hydroxyproline) [18,19].

Collagen Marine Sources

Marine collagens derived from sources like fish skin, bone, cartilage, and scales, including both marine vertebrates and invertebrates, have been found to exhibit superior bioavailability compared to collagens sourced from bovine or porcine origins. They demonstrate a higher absorption capability, up to 1.5 times more efficient, into the body [20]. This increased efficiency can be attributed to their low molecular weight and small particle size, facilitating rapid bloodstream circulation [21]. Furthermore, marine-based collagens share similarities with conventional bovine and porcine collagens in terms of their amino acid composition and biocompatibility [22]. Due to their similarities, marine collagens can be used as functional alternatives in a variety of applications. In instance, fish byproducts including fishbone, scales, and skins can be used to make fish collagen (Figure 2a). These byproducts are produced in significant amounts daily as a result of fish consumption and processing in various parts of the world. Due to this, fish shops and processing facilities discard between 50% and 70% of the original raw materials, which results in a substantial quantity of waste [23]. Table 1 represents the sources of collagen.

Extraction of Collagen

The initial step, preparation, varies depending on the kind of raw materials used. To lessen sample contamination, pretreatment procedures like washing, cleaning, and size reduction are required before extraction.[36] After the preparation, a light chemical pretreatment is carried out to improve the extraction's effectiveness and get rid of non-collagenous materials. Generally speaking, several pretreatments (alkaline or acid treatment) can be carried out depending on the source materials and the extraction process. Due to crosslinked collagen in animal connective tissue, pretreatment with a diluted acid or base is utilised to dissolve the collagen before extraction [37].

The raw materials are submerged in the acid solution during the acidic form of pretreatment. The collagen structure is able to expand by two or three times its original volume due to the penetrated solution, which causes the non-covalent inter and intramolecular connections to break [38]. Sodium hydroxide (NaOH) and calcium hydroxide (Ca(OH)₂) are primarily used in the alkaline pretreatment process over a period of time that might range from a few days to several weeks [39]. However, employing NaOH is more practical because of its greater propensity to swell, which makes it easier to extract collagen by speeding up the transfer of mass through the tissue matrix [40]

Extraction Methods

Collagen fibres have a stable inter- and intramolecular hydrogen bond crosslink structure, which makes them insoluble in water. Therefore, to improve the solubilization of collagen proteins and achieve their isolation during the extraction, certain extraction procedures must be used. The main techniques documented in the literature for collagen isolation from fish byproducts include the extraction of acid-solubilized collagen (ASC), extraction of pepsin-solubilized collagen (PSC), deep eutectic solvent (DES), and supercritical fluid (SF) extractions [41]. There are two methods of collagen extraction. Fig 1 represent the extraction procedure of collagen

- (1) Acid soluble collagen extraction
- (2) Pepsin soluble collagen extraction

Acid Soluble Collagen

Collagen's triple helix is hydrolyzed by acids (such HCl and AcOH) and its single chains are made solubilized in solution, where heavyweight proteins are depolymerized into smaller peptides (0.3–8 kDa).[42] One of the most popular substances used to extract collagen from animal and marine sources is AcOH.[43] While the other variables remained constant, the effect of AcOH with a range of 0.2-1.0 M on collagen extraction from sole fish skin was assessed. The greatest collagen yield was 15.968 mg/g at 0.6 M of AcOH when the AcOH concentration was gradually increased. However, the collagen yield decreased after 0.6 M.[44] The aggregated state of collagen molecules and



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AcOH concentration were associated with each other so that the collagen critical aggregation concentration increased from 0.518 to 1.581 mg/mL for alteration from 0.1 to 2.0 M of AcOH concentrations..[43]

Pepsin Soluble Collagen

The second main method for extracting collagen uses pepsin to help break up the triple helix's telopeptide sections, which makes it easier to dissolve collagen peptides in solution and increases extraction yields. A well-known pepsin called PSC is included in the extraction procedure. [45] Pepsin concentration, hydrolysis time, and the solid-liquid (S/L) ratio on pepsin-solubilized collagen are three crucial elements that must be optimised for more beneficial outcomes in order for pepsin-aided AcOH extraction procedures to be effective. [45]. When the other extraction parameters remained constant, the impact of pepsin concentration on the extraction yield of pepsin-soluble collagen was examined. The isolation yield significantly increased (66.35% to 79.93) with an increase in pepsin concentration (800 to 1200 U/g). Additionally, it was examined how much pepsin and AcOH were present in the collagen that was isolated from the skin of Nile fish.[46].

Other Methods

Ultrasound Extraction Method

Ultrasound was previously reported as a method for increasing the efficiency of collagen extraction from fish materials. However, the down-side of this method is that ultrasound could negatively impact the physicochemical and molecular characteristics of collagen[36]. As a consequence, the use of ultrasonication under the right conditions has a high potential for enhancing the extraction yield of collagen from fish materials. Furthermore, it may enhance the cavitation effect by disrupting the cell walls in skin tissue, resulting in the liberation of collagen[47].

Influence of Extraction Parameter on Collagen Yield

Effect of Temperature on Collagen Extraction

When utilising pepsin, temperature has a direct impact on it. It is best to maintain the temperature moderate (4–10°C), since this enzyme is particularly sensitive to high temperatures (over 60 °C), which could cause it to self-digest and become inactive. Pepsin's cleaving action is typically followed by a brief period of heating to 90 °C to inactivate the enzyme and stop it from further destroying the collagen structures.[48]. However, raising the temperature over collagen's denaturation point would cause the isolated proteins to thermally degrade.[49] Most fish sources of collagen are extracted between 4 and 10 °C, which enables pepsin to break down the crosslinks in the collagen triple helix without compromising the peptides' structural integrity.[50]

Effect of Extraction Time on Collagen Extraction

The diffusion mechanism, which has a substantial time-dependent influence over extraction, means that when extraction time is increased, collagen recovery will also increase. [51] The leached peptides may degrade as a result of prolonged extraction times. In this scenario, the collagen chains begin to be broken down by the acid solution, causing their breakdown and lowering the ultimate extraction yield.[52] The isolation time effect was studied at various times (3–15 h), and the results showed which time has a significant influence so that increasing the extraction time from 3 to 15 h resulted in an increase of 1.72% in the yield.[53]

Effect of Solvent Concentration

While all other experimental variables were held constant, the effect of AcOH concentration on the collagen yield of sole fish skin was studied utilising a concentration range between 0.2 and 1 M. The collagen output rose to 16 mg of collagen/g of fish skin as the AcOH concentration reached 0.6 M. Due to the degrading effect caused by the excess of acid, the collagen output fell to 12.5 mg of collagen/g of fish skin at a concentration of 0.6 M and higher.[54] Organic acids work better at dissolving collagen that isn't crosslinked and rupturing some of the inter-strand crosslinks in collagen.[55]





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Effect of Solid-to-Liquid Ratio

The mass of the liquid solution used for the extraction divided by the volume of the solid collagen source is known as the S/L ratio. The interactions between free protons and the amino acids of the collagen chains are often improved by increasing the quantity of solution, which also improves the breakage of the crosslinks found in the collagen helix. Since a high concentration of acid causes the collagen chains to be fragmented, results in formation of lower molecular weight peptides, a lower solid-to-liquid ratio speeds up the depolymerization rate of the peptides.⁵⁶ A S/L ratio of 1/55 was found to be the ideal condition since it significantly increased the extraction yield between 1/25 and 1/55. Then the extraction yield decreased as the S/L ratio increased from 1/55 to 1/65. The optimal solid-to-liquid ratio for AcOH extractions, according to studies, is midway between 1/40 and 1/60.⁵⁷ Several S/L ratios such as 1/25, 1/35, 1/45, 1/55, and 1/65 to evaluate the influence of S/L ratio on the extraction yield of pepsin-soluble collagen from the skin of gigantic croaker (*Nibea japonica*) when the pepsin concentration was 1200 U/g and the hydrolysis period was 8 h in 0.5 M AcOH.⁴⁹

Collagen Characterization Methods

FTIR: Fourier transform infrared (FTIR) spectroscopy is a frequently used method for examining the secondary structure of proteins in collagen characterisation. Since FTIR spectroscopy exposes each absorption wavenumber in the spectrum between 500 and 4000 cm⁻¹, it is important. [59,60]. The amide band FTIR spectroscopy confirmed the presence of amide A, B, I, II, and III bands in collagen extracted from bones of *Lutjanus* sp., where amide III showed the triple helix in extracted collagen [61]. Other studies have used FTIR to determine the type and chemical composition of collagen as well as the presence of collagen. For instance characterised PSCs isolated from mackerel (*Scomber japonicus*) bones and skin using FTIR spectra. The results showed that mackerel bones and skin were largely composed of type I collagen, a heterotrimer made up of two identical 1-chains and one 2-chain in the molecular form. 50 The FTIR spectra of collagens extracted from seabass scales using ASC and PSC extraction methods also show that the collagen is type I and that the treatment did not harm the functional groups in the triple helix [63]

Sds Page Chromatography

Collagen's molecular weight can be calculated using SDS-PAGE.[58]. The three -chains, specifically (1)2, (2) (M.W. 118, 116 kDa), and one -chain (M.W. 200 kDa), were present in the collagen that was isolated from the skin of sole fish.⁶⁴ Additionally, dimers or trimers (chains) can be seen in the SDS-PAGE depending on how they are put together and whether they have undergone post-translational modification. Two α 1 chains and one α 2 chain (about 100 kDa) are typical for fish collagen.⁶⁵

Circular Dichroism

Similar to other proteins, collagen's secondary structure, binding, and folding properties can be evaluated using a technique called circular dichroism (CD), which measures the differences in light's right- and left-circularly polarised light absorption [67,68] Circular dichroism (CD) may really show whether an isolated collagen molecule is in its original triple helical structure or in its denatured form.[70] Circular Dichroism is a quick technique, but because some proteins fold more slowly than others, such collagen and collagen fragments, it takes longer to study their folding characteristics. Thus, a prefolding should be carried out, especially for proteins whose folding characteristics are unknown. Before performing a circular dichroism (CD) examination, the protein needs to be prefolded for several hours to several days at 25 °C or on ice (in a refrigerator).[68] Collagen's triple helix displays well-defined CD transitions with positive and negative bands at 222 and 195 nm, respectively, in the supercoiled polyproline secondary structure (type II). The fact that gelatin, a denaturized form of collagen, lacks a distinctive CD signal can show that the collagen's CD signals are primarily caused by an organised fibril with triple helical units.[69]

Differential Scanning Calorimetry

Differential scanning calorimetry is used to assess the thermal characteristics of collagen (DSC). In the DSC, collagen absorbs heat with increasing heating and begins to unfold at a particular temperature (different for each species).[60] The structure of collagen molecules changes when temperatures rise. Collagen's maximum transition



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and denaturation temperatures are determined by monitoring the calorimetric energy flux.[59] Because amino acids are present in the collagen chain, DSC can be used to assess collagen's heat stability.[59] Because the hydroxyl group in Hyp can act as a hydrogen donor via chains, collagen with a higher Hyp content, for instance, has a higher denaturation temperature. The collagen isolated with acid had a denaturation temperature of 38.17 °C and a change in enthalpy (H) of 0.72 J/g, while collagen extracted with pepsin, which had a higher Hyproline content, showed a maximum denaturation temperature of 39.32 °C and a change in enthalpy (H) of 0.91 J/g. Another study found that seabass (*Lates calcarifer*) skin and swim bladder both had 79 and 83 (residues/1000 residues) of the drug, respectively [59]

Application of Fish Collagen

The use of synthetic medicines to treat wound healing may lead to medication resistance in some burn reactions. Additionally, there are numerous stages involved in wound healing, including coagulation, inflammation, granulation, proliferation, matrix synthesis, angiogenesis, fibrogenesis, wound contractions, and re epithelialization. These are all difficulties with wound healing. As a result, it is important to research drugs made from natural ingredients. Due to how slowly the damage heals, occasionally complications and pain are revealed. Collagen has many uses in biomedicine because of its biocompatibility, biodegradability, and higher ability to permeate lipid-free interfaces. Collagen's significance in biomedicine arises from its capacity to self-arrange and cross-link collagen fibres to create structures with great strength and stability [71,72]

The ability of marine collagen peptides from the skin of Nile tilapia (*Oreochromis niloticus*) to cure wounds was evaluated using in vitro and in vivo testing. The polypeptides that made up the prepared marine collagen peptides had molecular weights of less than 5 kDa, accounting for 99.14% of the total Collagen from Nile tilapia could speed up the healing of wounds in both in vitro and in vivo tests [74]. The collagen electrospun nanofibers obtained from tilapia used as a wound dressing. Electrospun tilapia collagen could help with rat skin regeneration and increased the adhesion, proliferation, and differentiation of human keratinocytes [75]. The jellyfish collagen implant could be exploited to develop therapeutic compounds for cartilage repair [76]. An effective collagen fibril based on swim bladder collagen from Bester sturgeon fish has been created. On the basis of the double network, they created hydrogels. The Young's modulus of the double network hydrogels ranged from 0.26 to 0.93 MPa, the denaturation temperature based on the DSC curve was raised even up to 90 °C, and it also had good biomechanical performance in vivo. They therefore proposed that this hydrogel be used to create artificial cartilage [77] pH-sensitive hydrogel based on fish scale collagen and carrageenan as a drug carrier to increase the bioavailability of allopurinol, a medication for treating gout and high levels of uric acid in the human body. This hydrogel might enhance the drug's bioactivity and physical characteristics in artificial bodily fluids [78]. The ability of tilapia fish collagen to regenerate periodontal tissue in vitro. Using the osteogenic markers ALP, COL I, RUNX2, and OCN at the gene level, the outcomes of cultivated human periodontal ligament cells with hydrolyzed fish collagen were examined. The synthesis of osteogenic-related proteins demonstrated favourable cell survival and osteogenic differentiation [79].

CONCLUSION AND FUTURE PERSPECTIVE

Current research indicates that a great alternative supply of collagen to commercially available sources is marine collagen. The best source of raw material derived from organic sources might be thought of as marine collagen. Additionally, the marine collagen has qualities like great availability, low danger of disease transmission, lack of religious restrictions, and potential for larger collagen yield. The structure and stability of marine collagen from vertebrate and invertebrate species were first briefly discussed in this work. Following that, various techniques for extracting collagen were reviewed, including acid extraction, pepsin-assisted AcOH extraction and ultrasound assisted extraction. Additionally, the effects of various extraction parameters on collagen yield, including temperature, time, solvent, and solid-to-liquid ratio, were also discussed. However, extraction conditions need to be optimised to achieve a better extraction yield. Then, various common techniques for identifying marine collagen were reviewed, including FTIR, SDS-PAGE, circular dichroism, and DSC. Marine collagen is desirable for





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biomaterials applications such as wound dressing and healing, drug delivery, therapies, and tissue engineering and regeneration due to its biocompatibility, water solubility, safety, biodegradability, anti-microbial activity, and functionality.

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Table 1 : Expected molar mass ranges for the peptides of collagen type I. The data for this table has been obtained from.66

Band of type1 collagen	Expected Molar Mass
$\alpha 1$	120 -150 kDA
$\alpha 2$	120 -150 Kda
$\beta 1$	150 – 200kDA

Table 2 : Sources of Collagen

Collagen source	Application	Remark	Reference
Tilapia Fish	Wound	Electrospun tilapia collagen nanofibers may speed up the healing of	24





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(skin)	Dressing	skin wounds when used as a bandage.	
Tilapia (scale)	Oral mucosa tissue	All fish collagen-based scaffolds have the potential to be employed in oral mucosa tissue, according to a histologic examination.	25
Carp fish scale	Drug delivery	The drug's release was also slower than in the control sample, and its stability was increased.	26
Jelly fish	Cartilage tissue engineering	In comparison to pure hydrogels, hybrid constructs made of jellyfish collagen and alginate support hMSC chondrogenic development and offer more stable constructs.	27
Lophisus litilon skin	Wound healing	Due to compatibility, collagen can assist in the healing of ulcers.	28
Sneak heads	Tissue Engineering	Collagen generated from fish scales has the potential to be used as a viable scaffolding material for a variety of biological applications.	29
Atlantic codfish	Wound healing	Tissue regeneration and engineering, Cosmetics, Orthopaedics	30
Eal fish	Wound healing	Blue biomaterial for biomedical application	31
Atlantic Cod (Gadus morua)	Tissue engineering	Collagen showed a concentration-dependent effect in metabolism and on cell adhesion of lung fibroblast MRC-5 cells	32
Sish scale (L. calcarifer)	Corneal tissue engineering	At day 15, 90 to 100% confluent development displayed similar limbal epithelial morphological characteristics.	33
Arothron stellatus fish skin	Wound healing	Collagen from the skin of Arothron stellatus fish, bioactive extract from Coccinia grandis, and the antibiotic ciprofloxacin are used to make the film scaffold.	34

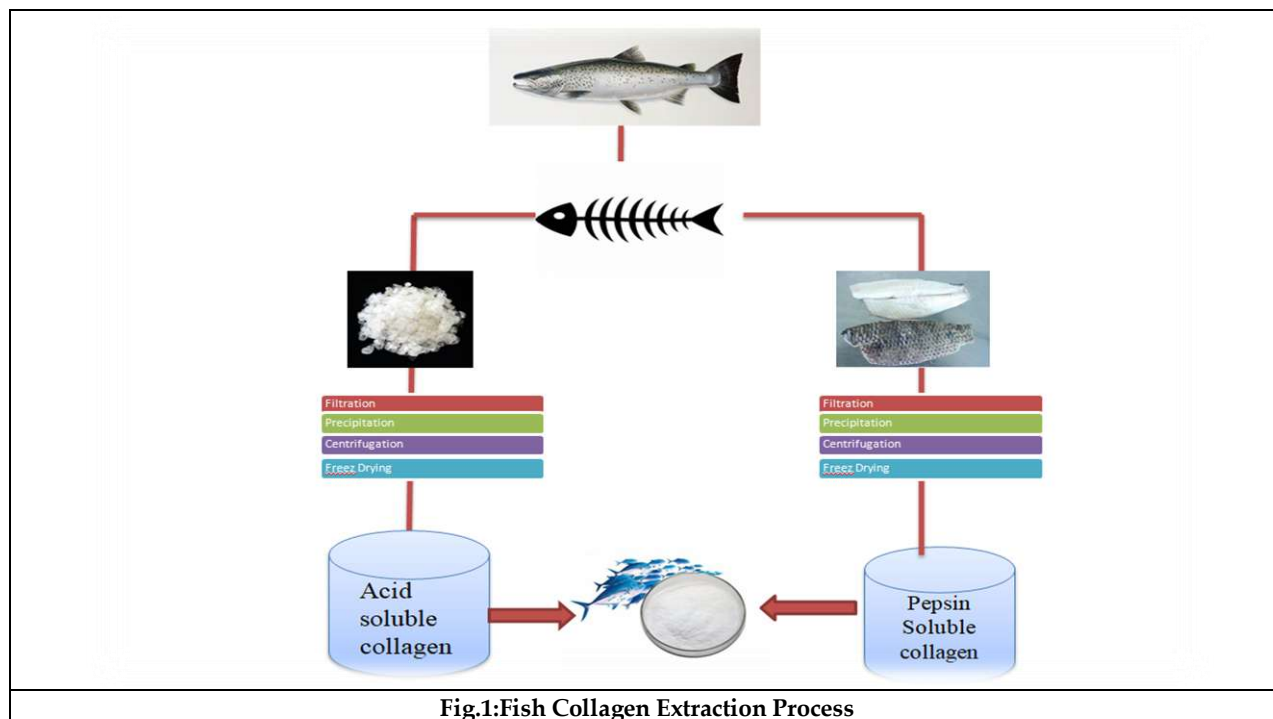


Fig.1:Fish Collagen Extraction Process





A Novel Cluster Head Selection Algorithm Based on Fuzzy Clustering (FC) and Modified Grey Wolf Optimization (MGWO)

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ABSTRACT

The goal of a Wireless Sensor Network (WSN) is to extend the network's life cycle, and topology control is critical to this goal. Particle Swarm Optimization is used to pick cluster heads based on Particle Swarm Optimization (PSO). In high-dimensional space, PSO is simple to slip into a local optimum, and the iterative process has a poor convergence rate. Propose a technique based on Fuzzy Clustering (FC) preprocessing and Modified Grey Wolf Optimization to address this problem (MGWO). First, the FC algorithm is used to create initial clustering for sensor nodes based on their geographical locations, where each sensor node belongs to a cluster with a given probability, and the number of first clusters is studied and discussed. In addition, the fitness function is created with WSN's energy consumption and distance aspects in mind. Finally, the MGWO is used to determine the CH nodes in hierarchical architecture. Experiments reveal that, when compared to standard methods, the proposed strategy was successful in lowering node mortality and prolonging the network life cycle.

Keywords: Modified Grey Wolf Optimization (MGWO), Wireless Sensor Network (WSN), Particle Swarm Optimization (PSO), Fuzzy Clustering (FC), Low-Energy Adaptive Clustering Hierarchy (LEACH).

INTRODUCTION

WSN network life cycle is a key measure of network topology quality, which is usually determined by the time when a particular number of nodes die due to energy depletion. One of the most essential aspects of WSN is topology control, which is critical for lowering communication interference and extending network lifetime. A commonly used and significant topology control approach is the hierarchical topology control algorithm based on clustering mechanism. WSNs are gaining popularity due to their low cost and ease, and they are being used in a variety of



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applications [1]. Sensor nodes in classic WSNs are often powered by batteries. Energy efficiency has become a key concern for WSNs due to the finite stored energy in batteries and the hassle of battery replacement.

Many recent research efforts have been devoted to designing energy-efficient algorithms to extend network lifetime [2], with cluster-based routings being one of them. A sink node and a specific number of clusters are typical components of a clustered WSN. A cluster head (CH) and cluster member (CM) node are found in each cluster. The CHs are in charge of receiving data from the CMs, consolidating the information, and then sending it to the sink. As a result, CHs use more energy than CMs. The CH is usually rotatory selected in a cluster to balance the energy consumption among the nodes. Many cluster-based routing schemes have been developed to help WSNs last longer [3-4]. However, energy consumption of sensors' batteries is unavoidable as long as the battery capacity is finite. Different clustering strategies are used to create energy-efficient WSNs with a longer lifetime. In different communication rounds, the CH positions are rotated among the nodes with the highest energy. To determine the next group of CHs among the nodes in the network, the approach considers the beginning energy, residual energy, and an optimal number of CHs. Then, based on the distances between them and the CHs, member nodes join different CHs to form clusters. To increase the energy efficiency of large-scale WSNs, a combined clustering and routing algorithm is presented [5]. To conduct the CH selection and multi-hop routing simultaneously, this technique uses a back-off timer and gradient routing. The hierarchical topology control approach relies heavily on the selection of CH nodes. LEACH is a well-known hierarchical topology control technique. LEACH's main principle is to choose CH nodes at random in a cyclic fashion, with the energy load of the entire network being evenly divided to each sensor node. The entire network lifetime is thereby increased. When LEACH selects CHs, however, there is a lot of randomness. This will most likely result in an imbalance of leftover energy between nodes, causing certain nodes to perish sooner. LEACH-C is an upgraded variant of LEACH that uses a simulated annealing technique to pick the best CH nodes [6].

In recent years, PSO has been a common approach of optimization that may be used to discover CH nodes and generate superior outcomes. PSO-C is a PSO-based clustering technique in which CH nodes are chosen based on the energy available to nodes as well as the distances between nodes and their CH nodes. PSO has also been utilized to locate CHs based on the distance and remaining energy of member nodes in previous research [7]. However, PSO-based algorithms frequently necessitate additional calculations and complex parameters. In high-dimensional space, PSO is simple to slip into a local optimum, and the iterative process has a poor convergence rate. The proposed work used Fuzzy Clustering (FC) and Modified Grey Wolf Optimization to address this problem (MGWO). This research proposes a novel CH selection approach based on MGWO and the initialization of CH nodes using Fuzzy Clustering (FC). Before starting the network, nodes are separated into numerous clusters of fuzzy subsets, and all of the sub clusters will run in parallel, reducing the size and time of each subset's computation. The rest of this paper is laid out as follows. In Section 2, related work is discussed. The model of CH selection in hierarchical topology control is discussed in Section 3. In section 4, it suggests the Fuzzy Clustering (FC) preprocessing approach as well as a modified GWO that takes numerous factors into account. Section 5 examines the evaluation of the FCMGWO algorithm as well as the analysis of the obtained results. Finally, in Section 6, discuss the key conclusions and future work.

LITERATURE REVIEW

Different algorithms for energy-aware sensor node clustering have been researched in the literature, motivated by the fact that energy efficiency plays a critical role in the WSN to extend the network's life time. The low-energy adaptive clustering hierarchy is one of the most popular and commonly utilised sensor node clustering algorithms (LEACH). LEACH is a probabilistic method that selects CH at random in each iteration. Despite the fact that LEACH reduces energy usage while increasing network Life Time (LT) when compared to static clustering and the Minimum Transmission Energy (MTE) method, it has several drawbacks. For example, LEACH can choose an SN with the least



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leftover energy as a CH later, lowering the network's LT. The researchers have created a number of alternative clustering algorithms to improve the efficiency of LEACH, such as Power-Efficient Gathering in Sensor Information Systems (PEGASIS), which is a chain-based technique. PEGASIS groups SNs into a chain, with each SN communicating only with its immediate neighbours. Every round, each SN in the chain has a turn transmitting data to the base station. PEGASIS saves more energy than LEACH, but its instability and significant latency make it unsuitable for large-scale networks. Ali et al [8] suggested an ARSH-FATI-based Cluster Head Selection (ARSH-FATI-CHS) combined with a heuristic called Novel Ranked-based Clustering (NRC) to reduce sensor node communication energy consumption while improving network Life Time (LT) in WSN. Unlike other population-based algorithms, ARSH-FATI-CHS dynamically shifts between exploration and exploitation of the search process during run-time to obtain a better performance-to-cost ratio and a higher network LT. During CH selection, ARSH-

FATI-CHS evaluates residual energy, communication distance factors, and workload. Simulate the planned ARSH-FATI-CHS and create various results to determine the WSN's LT performance. Compare the proposed results to state-of-the-art PSO to show that the ARSH-FATI-CHS strategy enhances the network's LT.

Zhu et al [9] developed an Improved Soft-k-means (IS-k-means) clustering algorithm to balance node energy consumption and extend the lifetime of the network in WSNs. To begin, apply the concepts of Clustering by Fast Search and Find of Density Peaks (CFSFDPs) and Kernel Density Estimation (KDE) to improve the soft k-means clustering algorithm's initial cluster centre selection. Then, using the soft-k-means' flexibility, reassign member nodes at the cluster's boundary based on their membership probability to balance the number of nodes per cluster. The notion of multiCHs is also used to balance the energy consumption of clusters. When compared to various clustering techniques from the literature, extensive simulation results show that the proposed algorithm may postpone the first node death, the half of node death, and the last node death on average for small-scale WSNs with single-hop transmission. Mehmood et al [10] presented LEACH-VH, a novel cluster-based routing protocol in which a new node type called Vice CH (VH) is introduced in addition to CH. The node with the highest residual energy among all nodes in a cluster is chosen as the CH, and the node with the second highest residual energy is chosen as the VH, which serves as the CH's backup node. The selected VH enters sleep mode, and when the CH's energy falls below a certain threshold, the VH awakens to operate as the CH and selects its VH. When compared to the Low Energy Adaptive Clustering Hierarchy (LEACH) routing system, the lifetime of a WSN increased by up to.

Salem and Shudifat [11] proposed a Low Energy Adaptive Clustering Hierarchy (LEACH) for extending the lifetime of the network and its energy in WSN. LEACH protocol, a cluster routing protocol that extends LEACH by finding a CH based on the shortest distance from the base station in order to reduce power consumption in CH nodes and throughout the network. As a result, the findings demonstrate LEACH's capacity to extend network lifetime while also decreasing and minimising power usage. Bidaki et al. [12] introduced an updated version of the LEACH protocol that uses the Kmeans clustering method to choose better nodes and hence extend the network lifetime in WSN. The proposed technique aims to build symmetric clusters and enhances network lifetime by lowering the average intra-cluster communications distance. When the sink node is located far away, it additionally evaluates the sink location and selects CH nodes that will use less energy to handle cluster members. As a result of the sensed data being sent to the closest CH, the suggested clustering technique can extend the network lifetime. Umbreen et al [13] developed Energy-Efficient Mobility based Cluster head Selection (EEMCS) for the lifetime enhancement of wireless sensor networks. The CH is chosen depending on specific criteria that have a significant impact on the sensor's energy consumption. The mobility level, remaining energy, distance to sink, and density of neighbours are used to compute each node's weightage. Single-hop/multi-hop communication is used for inter-cluster communication. Simulations are carried out using MATLAB. In terms of load balancing, network stability, energy depletion, and throughput, the suggested technique EEMCS outperforms the existing algorithms CRPD, LEACH, and MODLEACH. EEMCS uses significantly less energy and has a substantially longer network lifetime than other existing protocols.





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Al-Baz and El-Sayed [14] proposed a Node Ranked-LEACH to improve total network lifetime in WSN. Proposed research focuses on contemporary hierarchical routing techniques that rely on the LEACH protocol to improve WSN performance and lifespan. Based on the node rank algorithm, the proposed protocol improves the total network lifetime. To choose the CH of each cluster, the node rank method considers both path cost and the number of linkages between nodes. This upgrade, which may be represented as a CH, represents the true importance of a given node to success. In comparison to prior versions of LEACH protocols, the suggested method eliminates random process selection, which causes unexpected failure for some CHs in other LEACH versions, and it provides a decent performance in terms of network lifetime and energy usage.

Lin and Wang [15] proposed the Game theory based Energy Efficient Clustering routing protocol (GEEC) to extend the total network lifetime in wireless sensor networks. GEEC, which is a type of clustered routing protocol, uses an evolutionary game theory mechanism to attain both energy exhaust equilibrium and lifetime extension. Finally, thorough simulation tests are carried out. In comparison to the other two types of well-known clustered routing protocols, the experimental results show a significant increase in energy balance and energy conservation.

Problem Model for Clustering in WSN

Clustering is a key concept in WSN topology control, in which some nodes in the network are designated as CH nodes. CH nodes form the backbone network, in which other member nodes can be switched to hibernate mode to save energy, and the network's energy consumption is balanced by rotating the CH nodes on a regular basis. The network life cycle is also lengthened at the same time. A round is the name for the process of selecting CH nodes and reconstructing a network. The network model that was employed had the following attributes.

- Stochastically deploy sensor nodes in the region of interest, with node placements remaining stationary once deployed.
- Information acquired by sensor nodes can be relayed over a long distance.
- Each sensor node holds a set quantity of energy, which diminishes as information is transferred.
- In the WSN, there is a fixed-position base station (BS) that serves as the network's sink node.
- Each sensor node has the ability to process data as well as communicate data to the BS.

With the information transfer, the energy of sensor nodes would gradually deplete. When a sensor node's energy is gone, the node is considered dead. The network is declared dead when the number of dead nodes reaches a certain level. The goal of topology control is to make the network's life cycle as long as possible.

Energy Model: The standard LEACH energy model, in which both transmitters and receivers require energy. The radio electronics and power amplifier in the transmitter dissipate energy, and the radio electronics in the receiver dissipate energy.

The energy fading model is divided into two types based on the distance between a transmitter and a receiver node: free space and multipath. Set a threshold value d_0 , and when the transfer distance is less than d_0 , the energy consumption is proportional to the squared distance; otherwise, the consumption is proportional to the distance's forth power. When transferring 1 bit data across a distance of d , the energy consumption is determined as equation (1).

$$E_{Tx}(l, d) = \begin{cases} l \cdot E_{elec} + l \cdot \epsilon_{fs} \cdot d^2, & \text{if } d < d_0 \\ l \cdot E_{elec} + l \cdot \epsilon_{fs} \cdot d^4, & \text{if } d \geq d_0 \end{cases} \quad (1)$$

and when receiving 1 bit data, the energy consumption of the receiver is given in equation (2).

$$E_{Rx}(l) = l \cdot E_{elec} \quad (2)$$

where E_{elec} is the electronics energy, depending on the energy dissipated per bit to run the transmitter or the receiver, and $\epsilon_{fs} \cdot d^2, \epsilon_{fs} \cdot d^4$ are the energy cost of signal amplifier under two communication modes depending on the distance between transmitter and receiver.





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where E_{elec} is the electronics energy, and ϵ_{fs} is the energy dissipated per bit to operate the transmitter or receiver. $\epsilon_{fs} \cdot d^2, \epsilon_{fs} \cdot d^4$ is the signal amplifier's energy cost in two communication modes, dependent on the distance between transmitter and receiver.

The data fusion model implies that regardless of the number of nodes in a cluster, each node collects and sends 1 bits to the CH, and the CH compresses the overall information received to 1 bits. EDA is the energy cost of data aggregation.

PROPOSED METHODOLOGY

Because MGWO offers dynamic optimization capabilities, it has a significant benefit in handling the topology control problem in WSN. To choose the CHs, use the traditional MGWO algorithm. Fuzzy clustering is used to initialize before communication. The fitness function is designed with the goal of lowering the network's overall energy consumption while taking into account the maximum Euclidean distance between member nodes and their CHs, as well as the maximum distance between CHs and the base station.

Proposed Method of Initialization using Fuzzy Clustering (FC)

Proximate nodes are easier to assign to the same cluster during the clustering process, owing to the lesser energy required for transmission between nodes in close proximity. As a result, before the communication process, offer a method of initialization that divides sensor nodes into numerous fuzzy initial subsets using the Fuzzy Clustering (FC) model based on node positions. On a probabilistic basis, each node in the network belongs to one of the original subsets. Each node is assigned to an initial subset based on probability at the start of each round. Then, each subset works in parallel to choose CHs and transmit signals to the base station, reducing the computation's size and duration.

Fuzzy Clustering (FC) Model

The basic set is partitioned into multiple disjoint subsets with objects that are somehow comparable in conventional deterministic clustering. Real clusters, on the other hand, are frequently much more complicated in practise, and the belongingness of items to them is more or less ambiguous. As a result, such clusters are more hazy subsets of the original set than its sharp components. The state of clustering is expressed by a $n \times k$ matrix $M = [w_{ij}] (1 \leq i \leq n, 1 \leq j \leq k)$ in fuzzy clustering [16], which is a partition of a set of n items $Y = y_1, y_2, \dots, y_n$ into k fuzzy cluster C_1, C_2, \dots, C_k . The degree of belongingness of the i th object to the j th cluster is represented by w_{ij} . The matrices $M = [w_{ij}]$ must meet the following requirements:

- For each object y_i and cluster $C_j, 0 \leq w_{ij} \leq 1$.
- For each object $y_i, \sum_{j=1}^k w_{ij} = 1$.
- For each cluster $C_j, 0 < \sum_{i=1}^n w_{ij} < n$.

c_j represents the center of the cluster $C_j, 1 \leq j \leq k$. $\text{dist}(y_i, c_j)$ is the distance between the object y_i and the cluster center c_j , and it shows the degree of belongingness of object y_i to cluster C_j . The closer the item x_j is to the cluster centre C_j , the more likely it is that object x_i belongs to the related cluster C_j . To satisfy the conditions of matrix $M = [w_{ij}]$, use $\frac{1}{\text{dist}(x_i, c_j)^2}$ to define the degree of belongingness of object y_i to cluster C_j , and then normalise to derive the definition of the degree of belongingness w_{ij} , which is indicated in equation (3).

$$w_{ij} = \frac{\frac{1}{\text{dist}(x_i, c_j)^2}}{\sum_{l=1}^k \frac{1}{\text{dist}(x_i, c_l)^2}} \quad (3)$$





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Soft clustering is another name for fuzzy clustering. It permits an object to be a part of more than one cluster. To calculate fuzzy clustering, utilize an expectation maximization technique and construct k distinct clusters.

Method of Determining the Number of Clusters

For fuzzy clustering to manage the granularity of clustering and strike a fair balance between compressibility and accuracy, the right number of clusters is critical. For each cluster, the sum of squared error (SSE) is defined as

$$SSE(C_j) = \sum_{i=1}^n w_{ij}^p \text{dist}(y_i, c_j)^2 \quad (4)$$

where $p(p \geq 0)$ is a factor determining the priority weighting of the degree of belongingness w_{ij} .

The SSE for fuzzy clustering with k clusters can be used to measure the degree of the fit of the data, defined as equation (5).

where $p(p \geq 0)$ is a factor that determines how the degree of belongingness w_{ij} is prioritised.

The SSE for fuzzy clustering with k clusters, defined as equation, can be used to measure the degree of data fit (5).

$$SSE(C_j) = \sum_{i=1}^n \sum_{j=1}^n w_{ij}^p \text{dist}(y_i, c_j)^2 \quad (5)$$

The SSE inside each cluster can be reduced by increasing the number of clusters. The reason for this is because while there are more clusters to capture finer features of data objects, the objects in a cluster are more similar. Calculate the SSE(k) and draw the curve of SSE(k) on the variable k for a certain number of clusters $k > 0$. The appropriate cluster number is implied by the first (or most significant) inflection point on the curve.

Proposed Initialization Process Based on Fuzzy Clustering

Propose a mechanism for dividing wireless sensor nodes into k clusters at the outset. To begin, use the elbow approach to determine the optimal number of clusters. Then, using the fuzzy clustering method, calculate the matrix $w_{ij}, 1 \leq i \leq n; 1 \leq j \leq k$.

Before each round, assign each node to the appropriate cluster based on its degree of affiliation to that cluster. If node y_i meets the following criteria, it is applied to cluster C_j .

$$\sum_{l_1=1}^{j-1} w_{il_1} \leq r < \sum_{l_2=1}^j w_{il_2} \quad (6)$$

where r is a random number with a uniform distribution between 0 and 1 and represents a random number with a uniform distribution between 0 and 1. The conventional MGWO technique is then used to choose CHs in each initial subset in parallel, and node messages are delivered to the base station.

A. Design of Objective Function

Topology control aims to reduce overall energy usage, which is primarily driven by communication between nodes. According to research, the distance between nodes has an impact on energy consumption. As a result, the following three elements are taken into account.

1) Maximum average distance from a member node to its CH node





The subset is partitioned into K clusters, each with N_i member nodes, $i = 1, 2, \dots, K$, and the maximum average distance between KCH nodes is defined as equation (7).

$$dist_1 = \max_{i=1,2,\dots,K} \left\{ \frac{\sum_{j=1}^{N_i} d(CM_{ij}, CH_i)}{N_i} \right\} \quad (7)$$

The distance between member node CM_{ij} and its $CHCH_i$, is $d(CM_{ij}, CH_i)$.

2) Maximum distance from cluster head nodes to the base station

$$dist_2 = \max_{i=1,2,\dots,K} \{d(CH_i, BS)\} \quad (8)$$

3) Total network energy consumption

The overall network energy usage for a round of data cycle is defined as equation (9).

$$E_{sum} = \sum_{i=1}^K \left(E_{CH}^i + \sum_{j=1}^{N_i} E_{mem}^{ij} \right) \quad (9)$$

E_{CH}^i is the energy consumption for CH_i during a round, and E_{mem}^{ij} is the energy consumption for a member node in cluster i during a round, where K is the number of CH nodes. All three aspects should be taken into account simultaneously. However, the data for each of them differs in dimension and magnitude from the data for the others. A normalizing function in equation (10) is used to transform the data into a comparable level in order to synthesize the above indicators.

$$y = \frac{2}{\pi} \tanh^{-1}\left(\frac{x}{x_0}\right) \quad (10)$$

Equation is used to define the objective function (11)

$$f = \alpha \cdot dist_{t_1} + \beta \cdot dist_{t_2} + \gamma \cdot E_{tsum} \quad (11)$$

where $dist_{t_1}$ is the maximum average distance, $dist_{t_2}$ is the maximum distance from CH nodes to base station, and total energy consumption is the total energy consumption. With $\alpha + \beta + \gamma = 1$, E_{tsum} , and α, β, γ are positive elements that determine the priority weighting of $dist_{t_1}, dist_{t_2}, E_{tsum}$. Assume that $dist_{t_1}$ and $dist_{t_2}$ have a minor impact on the cost function, but E_{tsum} has a slightly higher impact due to energy being a major factor in WSN. As a result, we set $\alpha = 0.2, \beta = 0.3, \gamma = 0.5$.

Proposed Cluster Head Selection Method using Modified Grey Wolf Optimization (MGWO)

Topology control is used to choose K CH nodes from a list of candidates in order to minimise the objective function, which can be thought of as an optimization problem. With the expansion of the scale and complexity of WSN, traditional algorithms have numerous limits, however MGWO is a very effective way for handling such optimization problems.

Problem Model for Cluster Head Selection

CH nodes consume more energy than the other nodes in the clusters, according to the energy model. The length of the network life cycle is the most important metric for evaluating topology control performance. To avoid premature "death" of some CH nodes, the energy consumption should be allocated to every node in the network when selecting CH nodes. Compare each node's remaining energy against that of the entire network, and if the remaining energy is larger than the average degree, the node is added to the CH candidate set. The CH nodes in the candidate set are then chosen using MGWO to minimise the objective value. Meanwhile, in the WSN





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clustering process, the number of CH nodes is an important element. The method for calculating the number of clustering head nodes is shown in Equation (12).

$$K = \frac{S\sqrt{n \cdot \varepsilon_{amp}}}{\sqrt{2\pi(n \cdot E_{stat} + \varepsilon_{amp} \cdot d_{avd}^2)}} \quad (12)$$

where S is the size of the WSN detecting zone, n is the number of sensor nodes, ε_{amp} is the signal-enlargement amplifier's factor, E_{stat} is the energy cost for a node to transmit 1 bit data, and d_{avd} is the CH's maximum coverage range.

Proposed Method using Grey Wolf Optimization (GWO)

The GWO algorithm is based on the hunting behaviour of grey wolves, who prefer to hunt in packs. Grey wolves have a rigid social dominance four-level hierarchy, with packs ranging in size from 5 to 12. GWO was inspired by grey wolves' social intelligence, which prefers to live in groups of 5-12 individuals. This method considers four levels in order to imitate GWO's leadership hierarchy: alpha, beta, delta, and omega. Alpha, who can be both male and female and are the pack's leaders, is in charge of making decisions (such as hunting, sleeping location, and wake-up time). Beta is known for assisting alpha in making judgments, and its primary role is to provide feedback suggestions. Scouts, sentinels, guardians, elders, and hunters are all roles Delta plays. Omega wolves are ruled by Delta, who obeys alpha and beta wolves. Every other wolf must obey the omega wolves.

The best grey wolf candidate is termed alpha (α), and they are the dominant wolves in the pack in the social hierarchy of grey wolves. The alpha wolves' subordinates, known as beta (β), are the second best in the hierarchy. If the pack's alpha wolves aren't present, the pack will be led by beta wolves. Omega (ω) wolves are the lowest-ranking wolves. All other wolves must bow to the omega wolves, and they must eat last in a pack. Delta (δ) refers to the wolves in their pack who are not alpha, beta, or omega. The delta wolves must obey the alpha and beta wolves in their pack, but they must have dominance over the omega wolves [17]. In the GWO, the hunting process is guided by, and wolves follow them.

The following formula can be used to calculate GWO's encircling behaviour:

$$\vec{X}(t+1) = w \cdot \vec{X}_p(t) + \vec{A} \cdot \vec{D} \quad (13)$$

where \vec{A}, \vec{C} are coefficient vectors, \vec{X}_p is the prey's position vector, X represents the location of wolves in a d -dimensional space, d is the number of variables, w is the inertia weight, (t) is the number of iterations, and \vec{D} is denoted as follows:

$$\vec{D} = |\vec{C} \cdot \vec{X}_p(t) - \vec{X}(t)| \quad (14)$$

where \vec{A}, \vec{C} are written as follows:

$$\vec{A} = 2\vec{a} \cdot \overrightarrow{c_1} \cdot \vec{r_1} - \vec{a} \quad (15)$$

$$\vec{C} = 2 \cdot \overrightarrow{c_2} \cdot \vec{r_2} \quad (16)$$

where $\vec{r_1}, \vec{r_2}$ vectors generated at random in the range $[0,1]$. The acceleration coefficients c_1, c_2 represent the contribution of the knowledge element and the social factor, respectively.

According to the equation below, a is the encircling coefficient, which decreases linearly from 2 to 0 as the number of rounds increases:





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$$a = 2 - 2 \left(\frac{t}{T_j} \right) \quad (17)$$

T_j is the number of CHs for each initial cluster, and t is the number of iterations. In the grey wolf hunting procedure, alpha is regarded as the best candidate for the job, with beta and delta assuming knowledge of the prey's likely location. As a result, the three best solutions found till a given iteration are preserved, forcing others (such as omega) to change their positions in the decision space to match the best place. The technique for updating positions can be determined as follows:

$$\vec{X}(t+1) = \frac{\vec{x}_{ik1} + \vec{x}_{ik2} + \vec{x}_{ik3}}{3} \quad (18)$$

where the variables x_1, x_2, x_3 are specified and calculated as follows:

$$\vec{x}_{ik1} = \vec{X}_{k\alpha} - A_1 \cdot (\vec{D}_\alpha) \quad (19)$$

$$\vec{x}_{ik2} = \vec{X}_{k\beta} - A_2 \cdot (\vec{D}_\beta) \quad (20)$$

$$\vec{x}_{ik3} = \vec{X}_{k\delta} - A_3 \cdot (\vec{D}_\delta) \quad (21)$$

where $\vec{x}_{ik1}, \vec{x}_{ik2}$ and \vec{x}_{ik3} stand for the coordinate of CHk at a given iteration t .

Where, A_1, A_2 and A_3 are calculated as in above Equation. $\vec{D}_\alpha, \vec{D}_\beta, \vec{D}_\delta$ are calculated below equation.

where $\vec{x}_{ik1}, \vec{x}_{ik2}$ and \vec{x}_{ik3} are the coordinates of the CHk at iteration t

A_1, A_2 and A_3 are calculated as in the previous Equation $\vec{D}_\alpha, \vec{D}_\beta, \vec{D}_\delta$

$$\vec{D}_\alpha = |\vec{C}_1 \cdot \vec{X}_{k\alpha} - \vec{X}| \quad (22)$$

$$\vec{D}_\beta = |\vec{C}_2 \cdot \vec{X}_{k\beta} - \vec{X}| \quad (23)$$

$$\vec{D}_\delta = |\vec{C}_3 \cdot \vec{X}_{k\delta} - \vec{X}| \quad (24)$$

where $\vec{C}_1, \vec{C}_2, \vec{C}_3$ are computed using the equation above.

Modified Grey Wolf Optimization (MGWO)

The best three answers are utilised to update the position of each wolf in each generation or iteration of the GWO. Omega wolves make up a bigger proportion of the population and have lower fitness levels than alpha, beta, and delta wolves. The diversification ability of GWO in quest of better solutions can be improved by moving the weaker wolves in a directed method. The MGWO (Modified Grey Wolf Optimization) technique is presented. The wolves are ranked in ascending order of fitness in each generation. The top half are dubbed grey wolves, whereas the bottom half are dubbed upgraded grey wolves. Each upgraded grey wolf is paired with a master wolf to learn from. The following equations will be used by the wolves to learn from the master:

$$D_L = \omega |C_4 \cdot (x_{ikM} - x_{ikl})| \quad (25)$$

D_L is the distance between a master and slave wolf, $\omega \in [0, 1]$ is the learning coefficient, C_4 is derived by equation (25), x_{ikM} is a master wolf, x_{ikl} is an improved wolf, and S and M are evaluated using equation (26). In the case of a population of N wolves,

$$I = M + \frac{N}{2} M = 1, 2, 3, \dots \quad (26)$$

The new continuous position of the upgraded wolf is derived using equation principles as follows:

$$x_{ikn} = x_{ikM} - A_4 \cdot D_L \quad (27)$$





where x_{ikn} is the continuous solution and A_4 is calculated according to equation (27). Because feature selection is a binary problem, continuous solutions must be binary as well.

$$x_{lkd}(t+1) = \begin{cases} I(x_{ikn}) & \text{if } I(x_{ikn}) > rand \\ 0, & \text{otherwise} \end{cases} \quad (28)$$

where x_{lkd} is a new binary solution for a better wolf in dimension d , $rand \in [0, 1]$, and I is a sigmoid function defined by

$$I(x) = \frac{1}{1 + \exp(-10 * (x - 0.5))} \quad (29)$$

When all wolves' positions are changed, Equation (28) is used, but $rand$ is now set to 0.5. The upgraded wolves can now be incorporated with the population's master grey wolves and passed down to the next generation. The nonlinear control parameter adopted in (30) is used in place of to increase the number of iterations in the exploration stage.

$$a = 2 \left(1 - \frac{t^2}{T_j^2} \right) \quad (30)$$

RESULTS AND DISCUSSION

When a node's contained energy falls below zero, it is termed dead. The network is termed dead when the number of dead nodes reaches a certain threshold. Experiments are undertaken to mimic the life cycle of the network, including comparisons to the LEACH algorithm and the KBPSO algorithm, to demonstrate the efficiency of the proposed technique (FCMGWO).

Parameter Settings of Simulation Environment

The base station is created on the coordinates (x_s, y_s) . sensor nodes are randomly dispersed throughout the region of S . Assume that each data package has a set length of l , which is also taken into account. Table 1 shows the parameters that have been set.

Analysis of Life Cycle

Because the starting energy of nodes has an impact on the life cycle of a WSN, this experiment is broken into two parts:

1. Each node has the same beginning energy of 0.5J.
2. Node energy is evenly distributed between 0.3J and 0.7J.

Furthermore, the position of BS has a major impact on the WSN. The Base Station (BS) positions vary between (250,250), which is in the network's heart, and (500,575), which is on the outskirts of the monitored area. The FCMGWO, LEACH, and KBPSO algorithms are used to search for all possible scenarios. When the network's redundancy is substantial, the impact of the death of a few nodes on the network's performance is minimal. Then, as part of the network life cycle, consider node mortality. The association between node mortality and rounds is depicted in Figures 1 and 2.

As shown in Figures 1 and 2, when the BS positions are the same, regardless of whether the beginning nodes have equal energy or not, FCMGWO performs better than the other two algorithms, and the death time with FCMGWO is





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longer. The fundamental reason for this is that the proposed protocol FCMGWO allows for effective CH selection, which decreases communication between nodes' energy usage. At the same time, cluster leaders are given priority over nodes with low remaining energy, balancing the energy consumption of each network node and preventing some nodes from dying prematurely. As a result, the network's lifespan is extended. This is due to the fact that CHs need less energy to transmit messages to the BS at the centre. FCMGWO, on the other hand, outperforms the KBPSO and LEACH algorithms regardless of where the BS is located. In reality, the redundancy of network coverage is usually controlled within a particular range from a cost standpoint. In this instance, it is requested that all nodes in the network survive as long as possible in order to ensure network connectivity. The quality of service across the network will be dramatically reduced if one node fails. Then the WSN living rate is the primary attention indication. Figures 3 and 4 show the shifting curve of the node's living rate as well as the network life cycle. The curve slopes of FCMGWO are less than those of LEACH and KBPSO, indicating that the dying process is more gentle. This is the result of FCMGWO's consideration of both energy and distance, which apportions the energy consumption to each node, guaranteeing that none of the nodes runs out of energy too soon, essentially lengthening the life cycle

Total Data Messages Received at the Base Station

Figures 5 and 6 indicate the total number of data messages received at the BS. The figures show that the BS in the middle can receive more messages than the BS on the periphery. Furthermore, the proposed technique outperforms LEACH and KBPSO in terms of data message delivery. The reason for this is that the suggested method FCMGWO considers both energy and distance when selecting CHs. CHs are likely to be chosen from nodes with more remaining energy, ensuring network functionality and more data messages to the BS.

CONCLUSION AND FUTURE WORK

This research proposes a novel CH selection policy based on fuzzy clustering (FC) and MGWO for hierarchical topology control CH selection. The FC is used to cluster nodes at the start. The fitness function in the modified GWO is developed with three elements in mind: the distance from a cluster node to the CH node, the distance from the CH node to the base station, and the least energy consumption. The CH selection is then done with the updated GWO. The suggested technique can dramatically minimize node mortality and thus increase the network lifetime, according to simulation results. Plan to use (1) hybrid optimization algorithms to solve the problem of CH selection in the future, (2) try different clustering algorithms for initial clustering of nodes within the region, and design more appropriate algorithms for initial clustering to reduce the amount of computation and extend network lifetime.

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Table 1: Settings of Parameters

Variable	Parameter	Value
S	Distribution area	500×500
n	Number of nodes	100
(x_s, y_s)	Location of the base station	(250,250) or (500,500)
l	Length of every data package	4000bit
d_0	Threshold used in energy model	200
E_{elec}	Electronics energy	50Nj/bit





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E_{DA}	Energy cost for data aggregation	5nJ/bit
e_{fs}	Amplifier coefficient ($d < d_0$)	10pJ/bit/m ²
e_{amp}	Amplifier coefficient ($d \geq d_0$)	0:0013pJ/bit/m ⁴
p	Factor used in fuzzy clustering	1
α	Factor in objective function	0.2
β	Factor in objective function	0.3
γ	Factor in objective function	0.5
c1	Acceleration coefficient	2
c2	Acceleration coefficient	2
ω	Inertia weight	Decline from 1.4 to 0
V_{max}	Maximum of the velocity	200

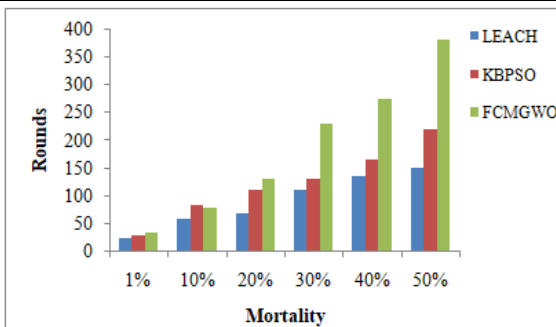


Figure 1: Relationship Between The Node Mortality and Rounds With Equal Energy With Bs At (250,250)

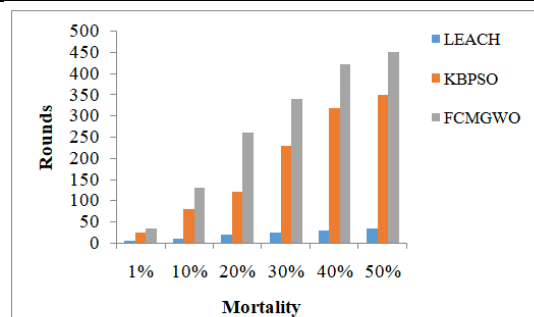


Figure 2: Relationship Between the Node Mortality and Rounds with Unequal Energy with BS at (250,250)

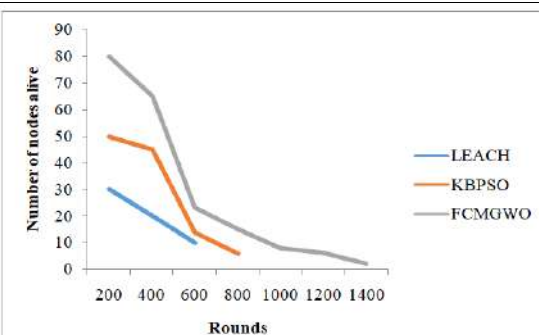


Figure 3: Number of Nodes Alive with Equal Energy With Bs At (250,250)

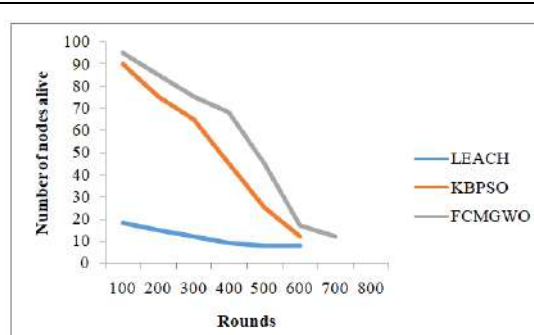


Figure 4: number of nodes alive with unequal energy with bs at (250,250)





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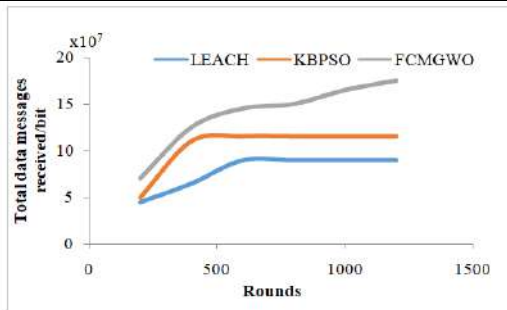


Figure 5: Total Data Messages Received At The BS (250,250) with Equal Energy

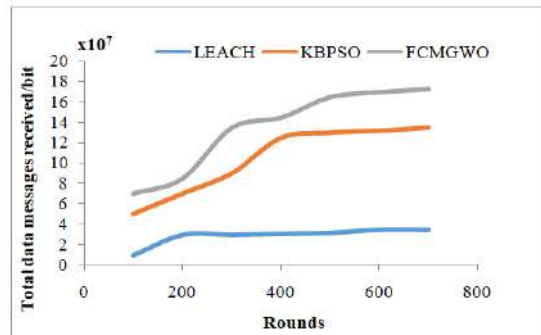


Figure 6: total data messages received at the bs (250,250) with unequal energy





A Study of Life Satisfaction and Personality traits of Healthy, Overweight, and Obese Adolescents

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ABSTRACT

The current research aimed at examining the relationship between life satisfaction and personality traits of healthy, overweight, and obese adolescents. It further aimed to find the difference if any in life satisfaction of healthy, overweight, and obese adolescents. The adolescents were grouped under three categories based on the body mass index. The current study utilizes a descriptive survey which was done using Big five personality questionnaire and multi-dimensional life satisfaction scale that was administered among students studying in schools of Jaipur. The results were analyzed using correlation and one-way ANOVA. The findings indicated that personality traits showed significant correlation with most of the life satisfaction dimensions in all the groups. Results of ANOVA indicated that significant pair wise differences exist on all the three groups of healthy, overweight, and obese adolescents with healthy adolescents having high means on all the dimensions of life satisfaction.

Keywords: family, self, personality, body weight, obesity, health, BMI

INTRODUCTION

The transition phase between childhood and adulthood is called the adolescence. This phase is between the years 10-19 years. It is an important stage that lays the foundations for both physical and psychological health. This stage is characterized by rapid modifications in cognition and psychosocial development. The prevalence of adolescent obesity has greatly increased and has emerged as a challenge in the public health domain. Adolescent obesity has both short-term and long-term health issues. Both physical and psychological ailments are associated with overweight and obesity. The recent COVID-19 pandemic reported significant associations between dysfunctional



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health, mental health pressures, and substance abuse [1]. Weight gain was subsequently associated with an increase in unhealthy eating behaviors, a significant decrease in physical activity, and deteriorating mental health of the adolescents [2]. This ultimately results in weight gain. Other than this, the environment in which we live, our home, the society also influence our mental health. The pre judices and discrimination associated with larger body size, commit to increasing mental health problems. Overweight adolescents are subjected to labeling which includes irresponsible, unfit, undesirable, ugly, and are also liable to bear high health care costs and more negative outcomes. These types of judgmental remarks not only make the individual guilty but give rise to negative feelings about oneself. In the long run, these comments lower self-esteem as well as lead to other mental health problems. Moreover, high body weight also becomes a problem when certain daily life activities depend on it. For example, the ride seats in an amusement park are naturally designed to fit normal-sized children and adults. Likewise, seats in an airplane also have a similar pattern. Therefore, being denied fun, entertainment and flights are some problems that an individual faces when they have high body weight. A study conducted by Baile *et al* (2020) on exploring the association between weight status, health-related quality of life and life satisfaction among adolescents. Approximately 1200 students participated and completed Health Behavior in School-aged children questionnaire. The students were then segregated under four groups of underweight, healthy, overweight, and obese. The findings indicated high health related quality of life and high life satisfaction was shown by boys as compared to girls. The obese groups had significantly low levels of both health-related quality of life and life satisfaction as compared to the healthy group. To conclude, overweight is associated with variety of psycho-social problems and is considered one of the most crucial and immediate health problems of today. [3] A study conducted by Sutin and Terracciano (2019) explored whether the relationship between personality traits and body weight extends to social attitudes. They examined around 1300 participants who were mothers with children, and they completed personality questionnaire, weight related attitudes and social interactions. The findings revealed that both high extraversion and high neuroticism were related to more negative attitudes towards individuals with overweight and obesity as well as they had high engagement in fat talk with their peers and around their children. In addition to this, high conscientiousness was related to fewer negative attitudes and interactions, but they had greater phobia towards obesity.[4]

METHODOLOGY

The purpose of the current study was to explore the relationship between life satisfaction and personality traits of healthy, overweight, and obese adolescents. A sample of 350 students were included in the study. The sample constituted 165 healthy, 113 overweight, and 72 obese adolescents under the age range of 14-19 years who were from English medium schools of Ajmer and Jaipur. A performa was designed which included socio-demographic details like height, weight, diet preference, grade, etc., along with life satisfaction and personality questionnaires. For the measurement of life satisfaction, the multi-dimensional student life satisfaction scale (MSLSS) was used and for personality, the Big five personality inventory (BFI-XS-2) was used. The BFI-XS-2 was developed by Christopher J. Soto and Oliver P. John (2017). The questionnaire has 30 items distributed among five traits- extraversion, agreeableness, conscientiousness, negative emotionality, and open-mindedness.

The Multi-dimensional Student Life Satisfaction Scale (MSLSS)- This scale was developed by Scott Huebner (1994). The scale of 40 items was distributed among five subscales of family, friends, school, living environment, and self.

Data Analysis

Following the administration of questionnaires, the students were segregated into three categories based on their obtained body mass index scores. The statistical analysis was done using descriptive, correlation, and one-way ANOVA through SPSS software.





RESULTS AND DISCUSSION

The aim of the study was to examine the relationship between life satisfaction and personality traits of healthy, overweight, and obese adolescents. The study also aimed to see the difference in life satisfaction of healthy, overweight, and obese adolescents. Based on the aim, it was hypothesized that there is a significant positive relationship between life satisfaction and personality traits of healthy, overweight, and obese adolescents. It was also hypothesized that there will be significant difference in the life satisfaction and personality traits of healthy, overweight, and obese adolescents. With reference to the means and standard deviations obtained following the analysis, it was seen that on the subscale of **family**, healthy adolescents had high satisfaction when compared to the other two groups (as indicated in **Table 4.1**). This is because healthy adolescents have better perceptions of family qualities like good communication, boundaries, safe space, and security, all of which keep them satisfied and improve their quality of life. On the subscale of **friends**, healthy adolescents had a slightly higher mean when compared to the other two groups. This implies that healthy adolescents have reciprocated friendships which keeps them included in activities where a partner is needed. On the **school** subscale, healthy adolescents also had a higher mean as compared to the other two groups. This implies that healthy adolescents are obedient, they do not have problems with discipline, and are always motivated to participate in school activities. On the subscale of **living environment**, healthy adolescents had a slightly higher mean when compared to the other two groups. This implies that healthy adolescents have safer environments and neighborhoods which increases their likelihood to engage in physical activities and outdoor games. Lastly, on the subscale of **self**, healthy adolescents had a higher mean as compared to the other two groups. This implies that healthy adolescents engage in high physical activity, which is an indicator of healthy body mass, which is an important determinant of good self-worth. For the trait of **extraversion**, healthy adolescents had a high mean as compared to the two other groups. This is because high levels of extraversion are significantly associated with a lower risk of physical inactivity. On the trait of **agreeableness**, overweight adolescents had a similar mean as healthy adolescents. This is because the trait of agreeableness is considered a protective factor for obesity. The trait is also associated with sensitivity and concern for others. On the trait of **conscientiousness**, healthy adolescents had a high mean as compared other two groups. This might be due to the associations of the sub-factors of conscientiousness trait like the tendency to be organized and disciplined to the habits of healthy adolescents in maintaining a proper diet plan and nutritional balance. On the trait of **negative emotionality**, obese adolescents had the highest mean as compared to the two other groups this is because high neuroticism levels are related to poor health and well-being. Lastly, on the trait of **open-mindedness**, overweight adolescents had high slightly higher mean than healthy adolescents. This is because overweight adolescents consider themselves perfectly healthy their perceptions of daily stressors, and life challenges, resemble the perceptions of a healthy adolescent hence open-mindedness is related to characteristics like creativity, insightfulness, curiosity, as well as excitement to seek new experiences which are shown by healthy adolescents.

With reference to the aim of this study, the relationship between levels of life satisfaction and personality traits of healthy, overweight, and obese adolescents, the results indicated that **healthy adolescents** showed a significant positive correlation between personality traits and subscales of life satisfaction (as indicated in **Table 4.2**). The trait of extraversion revealed a significant positive correlation with family, living environment, and self-subscale of life satisfaction. The trait of agreeableness revealed a significant positive correlation with family, friends, and self-subscale. The trait of conscientiousness revealed a significant correlation with family, friends, living environment, and self-subscale. The trait of negative emotionality did not reveal significant correlation. Lastly, the trait of open-mindedness also did not reveal significant correlation. On the contrary, **overweight adolescents** showed significant positive correlation between personality traits and subscales of life satisfaction except for negative emotionality. The trait of extraversion revealed significant positive correlation with friends and living environment subscale. The trait of agreeableness revealed significant positive correlation with family, friends, school, and self-subscale. The trait of conscientiousness revealed significant correlation with family, friends, living environment, and self. The trait of negative emotionality revealed significant negative correlation with all the subscales. Lastly, the trait of open-mindedness revealed significant positive correlation with family, friends, and school subscale.



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Similarly, **obese adolescents** showed significant positive correlation between personality traits and subscales of life satisfaction except for negative emotionality. The traits of extraversion, agreeableness, and conscientiousness revealed significant positive correlation with all the subscales of life satisfaction. Whereas significant negative correlation was observed between negative emotionality and all the life satisfaction subscales. The trait of open-mindedness revealed significant positive correlation with family, friends, living environment, and self-subscale.

Overall, the results indicated that the correlation between extroverts and family satisfaction is high for obese adolescents ($r = .627, p < .01$). This finding does not line with the current review of literature. This change in the families of obese adolescents regarding their acceptance in the family could be a result of the awareness about the importance of mental health. Nowadays obese adolescents tend to smile easily, like to meet people, and take a personal interest in others. Although they are mindful of their weight but make no effort to lose it. The healthy group also showed significant positive correlation between extraversion and family subscale. This implies that healthy adolescents who are outgoing and talkative, are surrounded by supportive family environment which provides them satisfaction and happiness.

The correlation between extroverts and friends satisfaction, is also high for obese adolescents ($r = .664, p < .01$). Overweight adolescents also revealed significant correlation between extraversion and friends subscale. This could be due to the changing times where being socially active is an important part of life, be it on the internet (social influencer) or in the society. A study conducted by Marengo et al (2020) aimed to examine the interplay between extraversion, neuroticism, and social media addiction. They used passive Facebook user data and mapped it to a scale of social media addiction. They concluded that adolescents who scored high on extraversion and neuroticism are prone to risk of social media addiction [5]. Obese and overweight adolescents like to be around multiple people and yearn for others if they are alone for too long. The correlation between extroverts and school satisfaction is significant only for the obese group ($r = .553, p < .01$). This implies that obese adolescents do not face difficulty in maintaining school decorum and they are happy to go there and have positive relationships with their teachers and friends. This may also be possible as the rate of obesity has become so prevalent that more than average of the classmates come under the obese group. On the contrary, healthy adolescents revealed negative correlation which suggests that may be teachers are more inclined and aware about the obese group which shifts their attention from the healthy group which decreases their satisfaction with the school environment. The correlation between extroverts and living environment is significant for all the three groups but is high for the obese group ($r = .639, p < .01$). This indicates that adolescents irrespective of their body mass and who are extroverts in nature were comfortable and satisfied by the sound privacy in their living environment.

The suitable conditions make it optimal to stay indoors. They perceive their living environment as a safe place to enhance their physical, mental, and emotional well-being. Lastly, the correlation between extroverts and self-subscale is significant for healthy group and obese group but high for the latter group ($r = .663, p < .01$). This implies that adolescents who are extroverts tend to have enhanced pleasure-related behaviors which promote not only self-satisfaction but also social satisfaction. Adolescents who are healthy, they have high physical and psychological self-satisfaction. On the contrary, extraversion is also associated positively with outcomes like lack of symptom decrease, weight gain/BMI, risky behaviors, and success/failure. The results indicate that the correlation between agreeableness and family satisfaction is significant for all the three groups but high for obese adolescents ($r = .656, p < .01$). This implies that obese adolescents are cooperative, polite, friendly, and kind individuals who have strong family support but engage themselves in emotional eating and external eating [6]. The correlation between agreeableness and friends satisfaction is significant for all the three groups but high for the obese group ($r = .675, p < .01$). This implies that highly agreeable people may stress over failure because they are worried about letting people down. This stress hinders in the way of successful weight loss as stress can make it difficult to resist temptation. The correlation between agreeableness and school satisfaction is significant for both overweight and obese group but high for the latter group ($r = .548, p < .01$).



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This implies that agreeableness has a direct effect on anti-social behaviors (general distress which causes mood and anxiety symptoms) and has a positive correlation with positive school environment (school justice, student-teacher relationship, and student-student relationship) [7]. The correlation between agreeableness and living environment showed a significant positive relationship only in the obese group ($r = .575, p < .01$). This indicates that favorable living conditions like the availability of unhealthy, processed food, and high-calorie food in contrast with limited access and high price for healthy foods are a contributor to the development and encouragement of overweight [8]. Lastly, the correlation between agreeableness and self-scale was significant in all the three groups but high in the obese group ($r = .631, p < .01$). This implies that agreeableness influences self-rated health as agreeableness is regarded as an instrumental trait that acts indirectly by guiding to achievements or social situations. It gives a sense of control, competence, and supportive relationships which positively affects self-esteem and well-being. The results indicate that the correlation between conscientiousness and family subscale was significant for all the three groups but high for the obese group ($r = .691, p < .01$). This indicates that obese adolescents who have the characteristics of conscientiousness abstain from showing aggression and can control their impulses in relationships [9]. The correlation between conscientiousness and friends subscale was significant on all the three groups but high for the obese group ($r = .716, p < .01$). This indicates that conscious adolescents are trustworthy, self-disciplined, and prefer teamwork with their peers and companions irrespective of their body mass. The correlation between conscientiousness and school subscale was significant only for obese adolescents ($r = .566, p < .01$). This indicates obese adolescents perform well at school, manage their school-life balance, and are successful in learning which helps them to lead a happier life. The correlation between conscientiousness and living environment was significant on all the three groups but high for the obese group ($r = .669, p < .01$). This indicates that conscientious adolescents flourish in favorable living environment conditions like availability of food, medical services, and nearby market areas irrespective of their body mass index. Lastly, the correlation between conscientiousness and self-satisfaction was significant for all the three groups but high for the obese group ($r = .696, p < .01$). This indicates that conscious adolescents are satisfied with their sense of self, are motivated, and goal-directed, and show perseverance in daily life situations irrespective of their body weight.

The results indicate that the correlations between negative-emotionality and family satisfaction was significant for both overweight and obese groups but high for the latter group ($r = -.636, p < .01$). This implies that poor family functioning promotes negative emotions and obesity in adolescents. They perceive that they are surrounded by unsupportive family environments which gives rise to inability to control negative emotions. The correlation between negative emotionality and friends was significant for both overweight and obese groups but high for the obese group ($r = -.678, p < .01$). This implies that engagement in unhealthy behaviors like drinking, smoking, eating high-fat snacks, etc. with peers and friends leads not only to obesity but also results in long-term addiction of these behaviors post adolescence. The correlation between negative emotionality and school subscale was also significant for both overweight and obese groups but high for the obese group ($r = -.610, p < .01$). This implies that obese adolescents are victims of bullying and ragging because of their high body weight, they tend to experience negative emotions like anxiety, depression, nervousness, and lose confidence later in life. The correlation between negative emotionality and living environment was significant for both overweight and obese groups but high for the obese group ($r = -.717, p < .01$). This implies that negative life situations contribute to neuroticism, which enables failure of coping mechanisms and hence promotes weight gain. Lastly, the correlation between negative emotionality and self-subscale was significant for both overweight and obese groups but high for the obese group ($r = -.627, p < .01$). This implies that obese adolescents are always surrounded by a cloud of negative emotions which decrease their sense of self. The results indicate that the correlation between open-mindedness and family subscale was significant for both overweight and obese groups but high for obese adolescents ($r = .325, p < .01$). This implies that obese adolescents are receptive to enjoying new experiences, they explore and try out new food items. An open-minded adolescent adds closeness and positivity to a family environment.

The correlation between open-mindedness and friends was significant for both overweight and obese groups but high in the obese group ($r = .309, p < .01$). This implies that open-minded adolescents have better relationships with peers and their partners. They tend to agree to things that their friends ask. They remain inclined towards trying out



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new restaurants with their peers. The correlation between open-mindedness and school subscale was significant only for the overweight group ($r = .215, p < .05$). This implies that being overweight is so common nowadays that this group receive special care because of their weight to enhance their school experience. The correlation between open-mindedness and living environment was significant only for obese adolescents ($r = .282, p < .05$). This implies that since open-minded adolescents are adventurous, they flourish best in areas where they are in the proximity to try new things daily. They notice changes in their environments quite easily. Lastly, the correlation between open-mindedness and self-subscale was significant only for the obese group ($r = .302, p < .01$). This implies that open-mindedness gives a positive sense of self to obese adolescents.

They are best at assessing the minute details of life. Their practicality facilitates them to highlight the positive sides in different situations while neglecting the negativities. With reference to the second aim of this study, the difference in life satisfaction of healthy, overweight, and obese adolescents was seen using one-way ANOVA and post hoc Tukey analysis. It was seen that significant differences were observed on the subscales of life satisfaction i.e., family, friends, school, living environment, self, and groups of body mass index i.e., healthy, overweight, and obese adolescents (as indicated in **Table 4.3**). Family functioning of healthy, overweight, and obese adolescents is different in various aspects. Healthy and overweight adolescents have love, care, and support for their family members which gives them security and a sense of belonging. Obese adolescents have slightly different familial environments. They have less supportive family environments which include family stress, absence of either the mother or father, maternal depression, unappealing, non-stimulating home, and lack of parental warmth, love, and acceptance [10]. Both healthy and overweight/obese adolescents have friends who promote behaviors according to their body type. Groups of healthy adolescents promote more physical activity and promote healthy eating behaviors in contrast to groups of overweight and obese adolescents who promote sedentary lifestyles and risky health behaviors [11]. Although the school setting remains the same for healthy, overweight, and obese adolescents, yet obese adolescents face additional difficulties like bullying, teasing, body shaming, ridicule, and judgment because of their heavy bodies. These factors not only affect their academic performance but also give rise to demotivation and isolation from the school environment. On the living environment subscale, rural areas tend to have low obesity rates as the supermarkets and residences have significant distance which aids in increasing the ability to practice healthy behaviors like walking which prevents obesity. Healthy adolescents have high satisfaction with themselves because self-rated health is suggested as a health indicator among adolescents. Both life satisfaction and self-rated health mirror an adolescent's contemplative judgment of which his or her life is going well.

CONCLUSION

It was concluded that the prevalence of overweight and obesity has risen so much that it is very common to find that majority of the adolescents have high body weight. This has negatively impacted the perception of parents, teachers, and peers to become over-protective and over-aware of the psychology of an obese adolescent. They have prioritized the psychological well-being of an overweight and obese adolescents by promoting positive family, school, living environment over the physical well-being of the adolescent. This shift in the perception of the caregivers is harmful in the long run as physical health is equally important as the psychological health.

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Table 4.1 Means and Standard Deviation for study variables of life satisfaction, personality traits, and body mass

Variables	Healthy (n = 165)		Overweight (n = 113)		Obese (n = 72)	
	M	SD	M	SD	M	SD
Family	4.72	1.16	4.28	1.49	3.31	1.19
Friends	4.23	.78	4.10	.88	3.02	1.55
School	4.08	.53	3.88	.71	3.09	1.22
Living Environment	3.77	.64	3.63	.86	2.60	1.28
Self	4.84	.91	4.33	1.37	3.24	1.85
Extraversion	19.95	3.37	19.50	3.16	18.03	4.59
Agreeableness	20.42	4.21	20.43	4.09	17.78	5.66
Conscientiousness	19.83	2.88	19.69	3.37	17.13	4.42
Negative emotionality	17.28	3.60	17.67	3.77	19.97	5.03
Open-mindedness	18.71	2.75	18.81	2.85	17.33	2.61

index of healthy, overweight, and obese adolescents.





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Table 4.2 Correlations between life satisfaction and personality traits of healthy, overweight, and obese adolescents.

Variables	Family			Friends			School			Living Environment			Self		
	Healthy	Overweight	Obese	Healthy	Overweight	Obese	Healthy	Overweight	Obese	Healthy	Overweight	Obese	Healthy	Overweight	Obese
Extraversion	.206**	.150	.627**	.145	.211*	.664**	-.135	.140	.553**	.240**	.209*	.639**	.233**	.180	.663**
Agreeableness	.220**	.474**	.656**	.272**	.551**	.675**	.036	.340**	.548**	.123	.169	.575**	.294**	.363**	.631**
Conscientiousness	.321**	.351**	.691**	.193*	.448**	.716**	.040	.154	.566**	.227**	.199*	.669**	.280**	.377**	.696**
Negative Emotionality	-.037	-.191*	-.636**	-.001	-.270**	-.678**	.100	-.195*	-.610**	.087	-.319**	-.717**	.110	-.201*	-.627**
Open-Mindedness	-.088	.233*	.325**	.044	.229*	.309**	-.071	.215*	.173	.041	.150	.282*	.009	.181	.302**

Note. * $p < .05$. ** $p < .01$.

Table 4.3 Means, Standard Deviations, One-Way ANOVA and Group Comparisons across groups of body mass index on subscales of life satisfaction.

	Healthy	Overweight	Obese	F(2,347)	η^2
Variables	M(SD)	M(SD)	M(SD)		
Family	4.72(1.16) _a	4.28(1.49) _b	3.31(1.91) _c	23.616*	.12
Friends	4.23(.789) _a	4.10(.881) _b	3.02(1.55) _c	37.406*	.17
School	4.08(.534) _a	3.88(.717) _b	3.09(1.22) _c	41.018*	.19
Living Environment	3.77(.647) _a	3.63(.863) _b	2.60(1.28) _c	46.629*	.21
Self	4.84(.916) _a	4.33(1.37) _b	3.24(1.85) _c	37.734*	.17

Note. Means with different subscripts differ significantly from each other. * $p < .001$.





An Examination of Internet Retail Purchasing Patterns among College Students: Exploring Consumer Behavior in Online Shopping for Products and Services

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ABSTRACT

This study looks into the factors that influence college students' decisions to shop online. Using focus groups as a research tool, this exploratory study conducted qualitative research. A content analysis program was used to look at the transcripts of the data. The data analysis process revealed several key factors that influenced college students to make online purchases, including the use of apps for online shopping, the frequency with which online shopping is used, the products you frequently buy online, your satisfaction with the online shopping experience, the efficiency of online purchases, and the effectiveness of return policies for online purchases. Random sampling was employed as the sample method in a study that used a standard questionnaire and 120 samples to obtain data. Overall, the study's conclusions help online retailers and marketers better comprehend college students' online buying preferences, allowing them to create marketing strategies that will give them a competitive advantage. The results of this study strengthen previous research on Indian customers' online retail purchasing habits.

Keywords: online-shopping, online-Purchase, service behaviour.



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INTRODUCTION

Using the internet, which is effectively an endless market, a client living in any nation can enter a contractual relationship with a trader operating in any other country. From this angle, buying consumer goods from any international web seller based outside of the buyer's country of residence constitutes a cross-border transaction. Consideration of whether to buy the chosen item from a website is especially crucial in accordance with customs due to the variations in the legal and linguistic surroundings, as well as occasionally in the company. a shop owned by foreign traders. Due to the enormous and endless market that the internet offers, even though there is a greater distance involved, the consumer may instantly purchase the desired goods by making a few clicks from home or work, saving time and energy. Additionally, clients with limited mobility may find it simpler to shop online. The customer can always place an order because they do not have to go to the retailer's store and are not limited by the business's operating hours. Due to the availability of commodities that can be purchased from locations other than the customer's own, the range of goods is significantly greater. Customers can also request delivery to their homes or places of employment. Online deals are easy to compare, enabling buyers to buy products that meet their unique needs and have the best terms (price, quality, other discounts). E-commerce gives companies unmatched opportunities to increase their market share, expand internationally at a low cost, and reduce costs. The principal applications of electronic commerce, issues with and fixes for its implementation, and services needed to support it are the main subjects of this article. This essay will also demonstrate how numerous organizational functional domains have been impacted by online shopping. The exchange of goods and services, the transfer of money or data, or both, over an electronic network—most frequently the internet—is referred to as online shopping. These business dealings can be between consumers, businesses, or even between consumers and other businesses.

NEED OF THE STUDY

Online shopping has significantly increased in popularity as a result of its convenience, speedy transactions, time savings, attractive sales promotions, etc. Although these factors are motivating, there are other barriers, such as the anxiety some internet users experience when providing their credit card number or other private information. Because online shopping is still in its infancy, there are no set rules that consumers must adhere to.

OBJECTIVES OF THE STUDY

1. To analyse the online buying behaviours of college students to buy goods and
2. services from internet retailers.
3. To look at the age of the respondents and frequency of using online shopping sites.
4. To look at the educational qualification of the respondents and satisfied with the
5. experience of online shopping

SCOPE OF THE STUDY

The study's main focus was on how college students shop online. Online purchasing is the main driving force behind this expansion in retail. Customers no longer need to go outside to shop. It has significantly changed how consumers purchase by placing the shopping process at their fingertips via computers and mobile devices. The main result of online purchasing has been the freedom for people to shop whenever they want, from anywhere. They are no longer need to wait until the business opens before making a purchase. While it has been possible to shop online for some time, the use of mobile has propelled e-commerce to new heights because consumers can utilize the device at any point in the sales cycle.



**Shahul Ammed and Nagarajan****LIMITATIONS OF THE STUDY**

Only college students should use online stores to purchase products and services. Due to the small sample size, the population as a whole cannot be accurately represented. The accuracy of the statistics could be affected by the respondent's own prejudice.

LITERATURE SURVEY

Ajzen and others (2010) have investigated how it affected consumers' perceptions of online shopping. I chose this subject because research on online shopping demonstrates that endogenous and exogenous factors, such as consumer characteristics, environmental factors, product characteristics, previous online shopping experiences, and trust in online shopping, both influence perceptions and intentions to shop online. Ali, Pervaiz (2010) has looked at Norwegian internet shoppers' satisfaction and loyalty in their study, "Online Shopping Customer Preference and Loyalty in Norway." Less than half of Norwegians are devoted to their online retailers, according to the survey's findings, although the majority of them are satisfied with online shopping. Islam, M. A., and Eri, Y. (2011) a study on "Indian Consumer Online Shopping Behavior." Finding out how various components of online shopping connect to customer purchase behavior was the main objective of the study. The author used an independent sample test technique to analyze the data. The author concludes that there are differences between consumers' purchasing behaviors whether they purchase in physical places and online after analyzing the data. At Jaipur National University, there were no appreciable disparities in the responses between male and female management students. The respondents have a favorable opinion of online purchasing.

According to Davis (2011)'s investigation, more attractive online stores were developed. This questions the necessity of studying what motivates consumers to shop online. To completely understand consumer perceptions of online shopping and their plans to engage in it, a framework must be employed to organize the complex system of influences brought on by these numerous factors. One advantage of e-retailers, according to Yu-Chen Chen et al. (2012), is their ability to give their customers in-depth information. On the other side, the concept of information overload contends that, above a certain point, having more information leads to inferior quality but a better subjective situation with regard to making decisions about purchases. Essay on modelling consumer behaviour in online purchase situations is a paper by Ying (2015). He examined the patterns of online shopping throughout a number of sessions. Shopping cart abandonment affects a lot of online storefronts. He looked at abandoned shopping carts in the context of online food purchasing. He specifically developed a combined model for selecting the cart, the order, and the amount to buy. The connections between the mistake words show how interrelated the three judgments are. A review of the available data shows that not all shopping cart abandonments result in lost sales. The unfulfilled orders are regularly completed by customers who collect abandoned shopping carts.

By using variables including the length of their shopping journey, the time since their last visit, the number of items in their basket, and the value of the bargain, customers are urged, among other things, to complete their abandoned shopping. Important managerial suggestions are given to marketers by the study on how to handle the problem of shopping cart abandonment. Limayem and Khalifa (2015) have analysed employed well-respected behavioral theories to explain online buyer behaviour in their 2015 study, "Drivers of internet shopping." The next stage was to identify the key factors influencing online purchases and evaluate each one's relative importance. An ongoing survey study was used for this. The researcher used simple charts and tabulation as tools for data analysis. The researcher concluded after analyzing and interpreting the data that Indian customers are becoming addicted to internet shopping and that they have many of the same traits as the rest of the world. The results demonstrate that views toward online shopping, expectations of the consequences of doing so, and social influence all have a significant influence on consumers' intentions. Shanshan Ma and others, 2016. Consider the two marketing strategies used by a manufacturer: selling a single product in a physical store or differentiating the product with a feature that isn't necessary and selling it in both a physical store and an online store. You can divide consumers into two groups based on whether or not they are loss averse. The adaptability of the manufacturer for online marketing is a subject of this



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essay. If so, how does the producer choose a reasonable discount price, and how many products should the producer make available via each channel? We determine the best discount method and product quantity under the conditions of different online business margins and varying expected consumer valuation. Finally, we look at how predicted customer value, valuation fluctuation, and loss aversion influence the ideal discount price and expected profit.

2018's Rakhi Thakur, this study aims to investigate the role of consumer participation in online review authoring, with a focus on specifically online shopping. Customers are increasingly utilizing online shopping as their primary screen, and marketers are taking advantage of this trend to engage customers in interactive communication, which makes it even more suited for boosting customer engagement. But this area of research is only now getting started. The current study is among the first empirical ones to look at how customer involvement influences the production of internet reviews. This study advances our understanding of marketing in the areas of consumer interaction, online reviews, and online purchasing behavior. Additionally, suggestions on how businesses might benefit from customers' online participation are given to retailers, along with advertising for better management.

Anjala S. Krishen, et al. (2019) Online has evolved from a fundamental basis to an adaptive one for shopping environments due to the diversity of online shoppers. User irritation brought on by information overload is the cause of the demand. The researcher employed simple charts and tabulation as tools for data analysis. After analyzing and evaluating the data, the researcher concludes that Indian customers are more dependent on internet shopping and enjoy a variety of its benefits. We employed a feedback control theory-based approach to solve the problem of consumer information overload online in a flexible manner. To demonstrate the usefulness of this feedback control, the feedback controller was evaluated using a design science methodology.

Menon (2020) has investigated, if consumers have a positive attitude regarding the Internet and a positive online shopping experience, they are more inclined to use it as a medium for making purchases. Escapism, pleasure, and arousal are three hidden features of the "enjoyment" construct that we identify in our theory. "Escapism" is described as the pleasure one experiences from engaging in pursuits that are absorbing enough to provide as an escape from the stresses of daily life. The term "pleasure" refers to the degree of happiness, delight, or pleasant sensations had while making an online purchase. The research's sample size was 150 respondents. The researcher used ANOVA (analysis of variances) methodologies and basic percentage analysis to analyse the data.

RESEARCH METHODOLOGY

Research Design: Descriptive research design was employed in the study.

Sampling Design: This investigation, random sampling was used as the sample method.

Sampling Size: 120 sample

Tools and Techniques: In this study used SPSS V23 Software for all my analysis data and interpretation. Percentage analysis is one of the most widely used statistical methods for reviewing data. Correlation

DATA ANALYSIS AND INTERPRETATION**Age of the respondents**

Source: Primary Data The above table shows that the classification of the respondents on the basis of age. 20.0% of the respondents are belongs to the below age group of 20years, 54.2% of the respondents are belongs to the age group of 21-30 years, 10.0% of the respondents are belongs to the age group of 36-50 years and the remaining 15.8% of the respondents are belongs to the age of above 50 years.

Gender of the Respondents

Source : Primary Data The above table shows that the classification of the respondents on the basis of their gender. 31.7% of the respondents are male and 68.3% of the respondents are female.



**Marital Status of the Respondents**

Source : Primary Data The above table shows that the classification of the respondents on the basis of marital status.30.0%ofthe respondents are married and the remaining 70.0%of the respondents are unmarried.

Educational Qualification of the Respondents

Source : Primary Data The above table shows that the classification of the respondents on the basis of educational qualification.48.3% of the respondents were completed UnderGraduate,33.3% of the respondents were completed Post Graduate and remaining 18.3% of the respondents are having other educational Qualification.

App Using For Online Shopping

Source: Primary Data The above table shows that App using for online shopping.25.8% of the respondents are using Flip kart, 23.3%ofthe respondents are using Amazon, 20.8% of the respondents are using Snap deal, 20.0% of the respondents are using Mynthra and remaining 10.0% of the respondents are using other online shopping sites.

Frequency of Using Online Shopping Sites

Source: Primary Data The above table shows that the respondents are classified on the basis of frequency of using online sites. 41.7% of the respondents are using monthly once, 10.0% of the respondents are using twice in a month, 16.7% of the respondents are using more frequently and remaining 31.7% of the respondents are using the online shopping sites rarely.

Product often purchased by you Through Online

Source: Primary Data The above table shows that product often purchased by you through online. 11.7%of the respondents are purchasing food items . 34.2% of the respondents are purchasing clothing, 20.0% of the respondents are purchasing Stationery, 25.8% of the respondents are purchasing Make up items and remaining8.3%of the respondents are purchasing others.

Satisfied With the Experience of Online Shopping

Source: Primary Data The above table shows that satisfied with the experience of online shopping, 35.8% of the respondents are highly satisfied. 45.8% of the respondents are satisfied, 10.0%of the respondents are not satisfied, and the remaining 8.3%of the respondents are not highly satisfied.

Online Purchase is More Efficient than Offline Purchase

Source: Primary Data The above table shows that online purchase is more efficient than offline purchase. 28.3% of the respondents are strongly agree, 41.7% of the respondents are agree ,20.0% of the respondents are strongly disagree and remaining 10.0% of the respondents are disagree.

Return Policy is Efficient for Online Purchase

Source: Primary Data The above table shows there turn policy is efficient for online purchase.90.0% of the respondents said return policy is efficient for online purchase, and10.0%of the respondents said return policy is not efficient for online purchase.

Correlation Analysis

In this table shows that the relationship between educational qualification of the respondents and satisfied with the experience of online shopping

Correlations

** .Correlationissignificantatthe0.01level(2-tailed).

This is a positive (.889) 88%correlation Pearson correlation significance (0.000). There are relationships between





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educational qualification of the respondents and satisfied with the experience of online shopping.

Suggestion

Online retailers can concentrate on enticing deals and discounts to appeal to college students. Online marketers should take tracking difficulties into account and guarantee timely product delivery to customers. Online retailers may also think about partnering with other private delivery services to supply their products to stores. The suggestion is that the online shops should focus on other product categories besides footwear for college students. For a boost in sales, online shops can also concentrate on the quality and pricing issues. For further sales growth, it is also advised to verify authenticity and safety when using internet sites and applications.

CONCLUSION

In conclusion, college students prefer to shop online and get goods from a variety of brands. Students also have more options for purchasing goods online than in real stores because to these shopping channels. Nowadays, ordering the majority of items is best done online. There is no requirement to go into stores and haggle with sales people. There won't be any more waiting in lines to check out and acquire your purchases. Without wasting much more money, time, or energy, anyone from anywhere can shop in peace. For college students to have a comfortable private purchasing experience, authenticity and user-friendliness can also be emphasized on.

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Table 1: Age of the respondents

S.No	Age	No. of Respondents	Percentage
1	Below20Years	24	20.0
2	21-30Years	65	54.2
3	36-50Years	12	10.0
4	Above50Years	19	15.8
	Total	120	100.0

Table 2: Gender of the Respondents

S.No	Gender	No. of Respondents	Percentage
1	Male	38	31.7
2	Female	82	68.3
	Total	120	100.0

Table 3: Marital Status of the Respondents

S.No	Marital Status	No. of Respondents	Percentage
1	Married	36	30.0
2	Unmarried	84	70.0
	Total	120	100.0





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Table 4: Educational Qualification of the Respondents

S.NO	Educational Qualification	No. of Respondents	Percentage
1	Under Graduate	58	48.3
2	Post Graduate	40	33.3
3	Others	22	18.3
	Total	100	100.0

Table 5 : App Using For Online Shopping

S.No	App Using for Online Shopping	No. of Respondents	Percentage
1	Flipkart	31	25.8
2	Amazon	28	23.3
3	Snapdeal	25	20.8
4	Mynthra	24	20.0
5	Others	12	10.0
	Total	120	100.0

Table 6: Frequency of Using Online Shopping Sites

S.No	Frequency	No. of Respondents	Percentage
1	Monthly once	50	41.7
2	Twice in a month	12	10.0
3	Frequently	20	16.7
4	Rarely	38	31.7
	Total	120	100.0

Table 7: Product often purchased by you Through Online

S.No	Product	No. of Respondents	Percentage (%)
1	Food items	14	11.7
2	Clothing	41	34.2
3	Stationery	24	20.0
4	Makeup items	31	25.8
5	Others	10	8.3
	Total	120	100.0

Table 8: Satisfied With the Experience of Online Shopping

S.No	Satisfied with the Experience	No. of Respondents	Percentage (%)
1	Highly Satisfied	43	35.8
2	Satisfied	55	45.8
3	Neither satisfied nor dissatisfied	00	00.0
4	Not Satisfied	12	10.0
5	Not Highly Satisfied	10	8.3
	Total	120	100.0





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Table 9: Online Purchase is More Efficient than Offline Purchase

S.No	More Efficient	No. of Respondents	Percentage (%)
1	Strongly Agree	34	28.3
2	Agree	50	41.7
3	Neither agree nor disagree	00	00
4	Disagree	24	20.0
5	Strongly Disagree	12	10.0
	Total	120	100.0

Table 10: Return Policy is Efficient for Online Purchase

S.No	Return Policy	No. of Respondents	Percentage (%)
1	Yes	108	90.0
2	No	12	10.0
	Total	120	100.0

Correlations

	Educational Qualification Of The Respondents	Satisfied With The Experience Of Online Shopping
Educational Qualification Of The Respondents Pearson Correlation Sig. (2-Tailed) N	1	.889**
		.000
	120	120
Satisfied With The Experience Of Online Shopping Pearson Correlation Sig. (2-Tailed) N	.889**	1
	.000	
	120	120





The Role of Mass Media in Enhancing Scientific Temper among University Students

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ABSTRACT

Scientific temper is pivotal in eradicating the scourge of blind belief and superstition. The much-touted demographic dividend in India can be tapped only when the youth imbibe empirical evidence over anecdotal or faith-based claims. In the age of a growing infodemic, the onus of enhancing scientific temper of its audience lies with the media. The limited research on the media's role and responsibility in developing scientific temper among university students gives the research its importance in paving the way for enhanced media coverage for promoting critical thinking among the youth. Employing the idea of Agenda-Setting theory and Media Salience, the researchers conducted an opinion survey among university students in Bhubaneswar, Odisha to map their perspective on scientific temper, belief in pseudoscience and impact of mass media in opinion formation about rational thinking.

Keywords: Scientific Temper, Pseudoscience, Mass Media, Agenda-Setting, Opinion Formation

INTRODUCTION

Infodemic and Need for Reliable Information

In the present day and age, after a global pandemic, there has been a growing demand for information but an even greater production and dissemination of information. Unfortunately, a large proportion of this disseminated information has contributed negatively by re-affirming regressive beliefs and practices among the general masses. Rovetta and Castaldo (2022) define infodemic as "an information epidemic that can lead to engaging in dangerous behavior." Further they state that media resonance and how information is presented to the public through the mass



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media influence infodemic. Unverified or biased media coverage on scientific issues is potent in inflicting an adverse effect on the perception of the masses leading to discrimination and a decline in stability. This has in turn challenged the fabric of social harmony affecting public health, and development. Therefore, the need to instil a scientific temper, a spirit of inquiry, and healthy scepticism has become critical to the growth of society.

Scientific Temper and its Significance in India:

A scientific temperament could be defined as an attitude of rational thinking and refers to an individual's inclination towards informed and evidence-based decision-making in every-day life. Mentioned in The Discovery of India by Jawaharlal Nehru as a solution to scientific problems as well as life's challenges, "Scientific Temper" has also found its place in the 42nd Amendment of the Indian Constitution in 1976. As a fundamental duty of all the citizens of India, Article 51 A(h) of the Indian Constitution states, "It shall be the duty of every citizen of India to develop scientific temper, humanism and the spirit of inquiry and reform. Furthermore, National Science Day of 2014 was dedicated to "Fostering Scientific Temper" by The National Council for Science and Technology Communication, Govt. of India. From healthcare, upholding human rights, education, disaster management, and more, everything requires logical interventions and reasoning. Therefore, with a teeming population of over 1.4 billion people spread across a land mass of about 3.3 million sq. kilometres with over 65% of its people being below 35 years of age, the development and enhancement of scientific temper among its youth is pivotal in ensuring the wellbeing and development of the country.

Importance of Media in Dissemination of Scientific Information

Misinformation coverage on health issues like HIV AIDs, Depression still causes stigma affecting the health care system, the patients, and the society adversely. The superstitious beliefs and practices associated with health issues also lead to endangering life as well as resources and the COVID-19 Pandemic is a testament to that. Moreover, the lack of scientifically informed coverage on Homophobia, Racial Discrimination, and other forms of discrimination leads to violation of Human Rights and undermines the Human Resources of the nation. Emphasis on the enhancement of Scientific Temper can better equip the citizenry to deal with the fear of the unknown with reason and compassion. Last but not least, the enhancement of Scientific Temper can direct the intellectual faculties in the direction of development and propel the youth on the path of nation-building. Therefore, this research will help understand the perception of Indian Youth on the role of media in enhancing Scientific Temper.

Theoretical Framework

The media play a central role in influencing audiences' cognitions and attitudes. They impact the manner in which public perceive and respond to the social world. The agenda-setting theory coined by Maxwell McCombs and Donald Shaw (1972) refers to the ability of the mass media through news coverage of specific issues in shaping the audience perception about the relative importance and salience of such news stories. By providing strong cues and continuous attention to a particular issue, media coverage impacts the way people rank the most important news story. By framing stories with a particular slant, the media influences people by telling them what to think about both in an explicit and implicit manner. The priority given to a news generates public discourse. Thus, power of the media lies in its ability to focus public attention and set the agenda. Media Salience refers to the degree to which certain issues grow into prominence or stand out among others while also looking into the shaping of individual perception on the issue. It states that the issues growing into prominence are the ones that the public considers important and is aware of referring to first-level agenda-setting theory or object salience. However, in addition to enhancing media exposure to certain issues or 'objects', media also plays an important role in creating public opinion around the issue by emphasizing specific aspects of the issue and presenting it in a way to grab the attention of the audience referring to second-level agenda setting or attribute salience. The theory brought evidence of the power of the media in shaping public opinion. That stands true for the discourses on science and scientific temper as well. The lack of understanding and to some extent, alienation of scientific temper could be attributed to the limited coverage of science, the portrayal of science, as well as an increased coverage of issues dealing with pseudoscience. However, with the use of agenda-setting power of the media, the narrative of scientific temper can be enhanced to a huge extent.



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REVIEW OF LITERATURE

Franzen, Weingart & Rodder (2011) forwarded the concept of 'medialization' which refers to the mutual relation between science and mass media. They argue that mass media gives legitimacy to science among the public. Thus, media attention leads to public support for science. Boykoff (2015) highlights the important role played by media in shaping the construction and maintenance of discourse about science. Media representations create narratives for communicating science to the public through the important role of translation and interpretation. Media portrayals are an important factor in public understanding and engagement with science. Schafer (2011) terms mass media as the main source of information about science for most of the people in our society. Further, the author states that media play a strong role in pushing science issues onto public agenda. Therefore, the news media acts as a tool of agenda building for science issue. Weingart & Guenther (2016) call for democratization of science whose core element is engagement with the public. They term credibility of communication and trust in the communication as the most important factors in science communication. Liang et al (2014) talk of building a buzz about new scientific research by using cross-media channels that include legacy journalistic outlets, new media and personal social networks. They suggest use of multiple online channels can act as amplification for public outreach. Suleski & Ibaraki (2010) through their research tell us that scientific literacy among the public can be raised by news media coverage. But the modern scientific community has to take the responsibility of communication as public always turn to mainstream media for science news. Bucchi and Trench (2021) provide a perspective on science communication as social conversation which they feel expands and deepens its quality as it becomes more of an interactive communication. They talk of long-term continuity in communication which can take the form of a culture.

Objectives of the Study

- 1) The study is an attempt to gauge the perspective of university students about scientific temper and its utility.
- 2) The study will try to decipher the role of mass media in developing scientific temper among the university students based on their responses to the survey.

RESEARCH METHODOLOGY

This research used survey method where a questionnaire through google form was used to collect the data from 100 students of different universities located in Bhubaneswar, Odisha. They are Birla Global University, Utkal University, RD Womens University and KIIT University. The students were selected through purposive sampling method and the age category of the respondents range from 18-24 years. As university students, they regularly use mass media for accessing news and information in their everyday life.

Findings

The following is a brief summary of the findings reached at after analysing the respondents' response.

- 64.4% of the students consume news and information from media sources on a daily basis and the rest of them on a weekly basis.
- 67.3% of the students consume news and information from online news websites while for the rest, the sources of news and information were newspapers, television and social media platforms
- 79.2% of the students said that they trusted the media as a reliable source of information.
- 84.1% of the students believed that the media has a significant influence on public opinion formation.
- 83.2% of the students believed that the media plays a very vital role in shaping the audience perception about the relative importance and salience of such news stories.
- 26.7% of the students shared that the horoscopes and pseudoscientific content from various media sources, has a 'Significant influence' on people's beliefs and in their decision makings while 56.4% students mentioned that such content has 'Some influence'. This makes it clear that the majority of the respondents believe that the horoscopes and pseudoscientific content has an influence on people.



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- Only 13.9% of the students said that they were very familiar with the concept of Scientific Temper. 40.6% of them said that they were somewhat familiar with the concept, 35.6% mentioned that they were not very familiar while 9.9% of the students said that were not at all familiar with the concept of Scientific Temper.
- When described what scientific temper meant as enshrined in the Constitution of India, 96% of students believed that enhancing scientific temper is important.
- When asked if the media can play a significant role in enhancing scientific temper, 82.2% of the students agreed to it.
- When it comes to the type of media content that can be effective in enhancing scientific temper, among the multiple options given, 46.5% said that the news articles can be an effective way while 49.5% said that documentaries can play an important role. Further, 47.5% students said podcasts can be an important way to enhance scientific temper, 44.6% to educational YouTube channels and social media discussions respectively and 1% of students said that memes play a vital role in enhancing scientific temper.
- Lastly, when asked on what aspects of scientific temper should the media emphasize, 58.4% of the students mentioned that evaluating the sources of information should be emphasized. Further, 51.1% said that there is a need for questioning assumptions. 63.4% mentioned that analysing evidence is a major aspect and 39.6% said that the media should emphasize on recognizing biases. Finally, 38.6% of the students said that the media should emphasize on identifying logical fallacies.

The objective of this study was to understand the perspective of university students about scientific temper and the role of mass media in enhancing the same. The findings suggest that media plays a very vital and significant role in enhancing scientific temper especially among university students where majority believe in media as a reliable and trustworthy source of information. The findings also suggest that majority of the students agreed that media has a prominent role in shaping and influencing opinion formation among people. The research findings highlighted that various media content in the form of news articles, documentaries, podcasts, educational videos and social media discussion are an effective way to promote scientific temper. Further, the findings underscored that media holds the responsibility to engage and encourage people to question the assumptions, evaluate the source of information and analyse the evidence to arrive at informed opinions, especially among university students who are constantly exposed to various news and information across several media platforms.

CONCLUSION

Mass media serves as a powerful tool for setting the agenda of issues that society should focus on. The utility of the agenda-setting function of mass media lies in its profound impact on raising awareness and shaping the discourse about scientific temper among the students. It provides a platform for informed discussions on important issues. By disseminating accurate information and debunking pseudoscientific claims, media outlets can serve as critical educators in combating pseudoscience which has proliferated in the age of digital information.

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A Comprehensive Analysis on the Intelligent VLSI Systems Design and Applications

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ABSTRACT

With the increasing research advances in the Integrated Circuit (IC) technology, the design complexity also increases and this in turn increases the variations in the circuit development process and reduces the turnaround time in any IC chip manufacturing. The existing methodologies are not automated, resource-intensive and most importantly time –consuming. These challenges necessitate the need to develop advanced technologies. Recently, Artificial Intelligence (AI) has shown an increased potential in enabling automated modules and techniques for processing the complex tasks in the VLSI design, development and testing. The integration of emerging AI technologies such as Machine Learning (ML) and Deep Learning (DL) in the manufacturing process of Very Large Scale Integration (VLSI) devices greatly reduces the processing time required for understanding data abstraction levels in VLSI models. The design and development of intelligent VLSI models improve the overall yield of Integrated circuits. This research study reviews the AI algorithms and models that are currently employed in VLSI designing process. Finally, this study also discusses about the challenges associated with it while implementing highly intelligent design and its future scope.

Keywords: Very Large Scale Integration (VLSI), Artificial Intelligence, Machine Learning, Deep Learning, Integrated Circuits





INTRODUCTION

The electronics industry particularly the field of Integrated Circuits (ICs) is currently experiencing a technological revolution with the introduction of semiconductor technologies like Complementary metal-oxide semiconductor (CMOS), Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET), etc. These technologies are playing a predominant role in developing modern day chips or microchips [1]. Furthermore, the number of transistors embedded in a same or single chip has increased unprecedentedly in recent times. In the micro/nano electronics industry, the ultimate downscaling of transistors has resulted in improved circuit device performance. However, the integration of complex digital circuits on a same chip is achieved by using the modern VLSI technology [2]. The increased requirement of small and portable electronic devices among people has now resulted in developing power-efficient designs with advanced features. The state-of-the-art VLSI models are currently used to meet the emerging electronics industry requirements. The downscaling of circuits (goes up to sub3nm approx.) has become a key factor for achieving a higher device performance [3].

On the other hand, the downscaling also results in reducing the transistor dimensions and creating many challenges like increased circuit process complexity, increased leakage, decreased gain and increased sensitivity to the process variations. Further, these challenges also impact the circuit's process and operations, thereby impacting the propagation delay, timing and overall chip yield [4]. The nano-scale increase in process variations is considered as one of the major reasons for yield loss. When compared to CMOS, the Field-Effect Transistor (FET) is highly tolerant to the process variations [5]. Even in FET, the model performance is affected by circuit scaling. This results in the requirement to introduce advanced technologies in the VLSI design flow to enable enhanced circuit optimization and deliver enhanced performance. The performance of any Electronic Design Automation (EDA) tool depends on the used electronic chip's turnaround time. [6] With the existing design constraints, the rule-based methodologies consume more time to produce an optimal solution. Also, the existing methodologies are mostly not automated and time-sensitive, resulting in a delay. When an issue arises, it will be a tedious task for the designers to know about the root issues and fix it. Artificial Intelligence (AI) is recently preferred for solving various challenges in different fields. AI mimics the human intelligence to interpret human like decisions while executing the complex tasks. As the subsets of Artificial Intelligence (AI), Machine Learning and Deep Learning techniques are currently used for analysing the data, enabling logical reasoning, predicting the results and perceiving the outcome for future reference. ML/DL models has the ability to perceive the data patterns and make decision at high computational speed. The application of ML/DL algorithms is endless in VLSI circuit design and technology. Various opportunities are available in VLSI design and EDA technology for integrating ML/DL solutions to automate the IC design and manufacturing process [7]. The existing analog and digital ICs are highly dependent on CAD tools in various design levels from initial stage to developing final layouts. The advanced CAD design tools used for VLSI design process are becoming more complex due to increased number of transistors used in a single chip. The ML/DL algorithms are used to achieve automated chip fabrication solutions. This research study summarizes the utilization of ML/DL algorithms in VLSI design flow [8].

EXISTING METHODOLOGIES

The idea of integrating Artificial Intelligence (AI) in VLSI design has started in earlier 1980s [9], a period when researchers have analysed the scope, objective and necessity of introducing AI algorithms in CAD design tools, which are used in different VLSI design levels (both in internal and external design). Researchers have also explored and showcased the significance of including AI extensions in CAD tools [10]. Some researchers have [11] focused on applying AI algorithms in IC manufacturing to leverage design assistance and automation. The state-of-the-art AI and ML technologies have gained increased research attention from the EDA researchers involved in the design, development and application of VLSI technology. Recently, Neural Networks (NNs) are also implemented in designing the analog and digital VLSI circuits [12]. Some researchers have also reviewed the optimization of physical



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circuit design with the data analytics [13]. A research group have also listed out the opportunities and challenges in implementing machine learning algorithms in asynchronous VLSI design and also developed a design recommendation model to suggest an appropriate ML algorithm based on their required RTL logic, circuit synthesis and routing [14]. The IC testing process is also reviewed by implementing ML/DL techniques. The existing research works have also detailed the utilization of ML/DL algorithms in the areas of power analysis, physical circuit design, fault diagnosis, and analog design analysis [15]. Some research studies have also highlighted the application of machine learning in the microchip designing process [16]. Here, the reinforcement learning approach is introduced to analyse the circuit design space and other time related complexities to achieve good results. The introduction of AI in electronic design automation has greatly assisted the circuit designers to optimize the design flow. A comprehensive analysis has also been presented to integrated ML/DL in different circuit levels [17]. Recently, a detailed overview of incorporating deep learning and machine learning techniques in VLSI design is discussed in [18]. The design levels of any VLSI circuit included an internal and external design. The general design flow is depicted in Figure 2 and 3. The detailed analysis on the introduction of AI/ML algorithms are presented in the section 3.

AI in VLSI Design Flow

In recent times, Artificial Intelligence and machine learning plays a significant role in almost all the scientific and technological domains. The big data generated in every field can be analysed in the form of data patterns and it can be stored for future analysis and predictions [19]. These learning patterns can also be applied to solve various real-time challenges. There are three main types of Machine learning approaches such as reinforcement, unsupervised, and supervised learning approaches.

AI Models & Algorithms**Supervised Learning**

Supervised learning included two main tasks: regression continuous functions and classification, regression is a statistical approach mainly used to numerically predict the. Also, both the regression and classification can be considered as the learning function to predict the mapping function. [20] The most significant challenge is this learning function requires more labeled training data, which is very challenging for various VLSI applications. The well-known supervised algorithms include, Random Forest (RF), Decision Tree (DT), and Support Vector Machine (SVM).

Unsupervised Learning

In contrary to supervised learning method, unsupervised learning can process the unlabelled data. However, achieving the required output for a given input vector will remain as a highly challenging task. The applications of unsupervised learning include, principal component analysis, dimensionality reduction and clustering. The most well-known algorithms include hierarchical clustering, k-nearest neighbour and k-means clustering.

Deep Learning

Deep learning is highly suitable for large-scale data processing and build complex data processing models. Artificial Neural Network (ANN) is an example of deep learning model. It is a mathematical function that maps the input and output values. Comparatively, Deep Neural Networks (DNNs) have the ability to implement complex mapping [21]. These AI/ML/DL advancements have the increasing scope to address the challenges associated with IC and microchip design and manufacturing. The application of AI model in different abstraction levels are detailed below

Implementation**Circuit Level**

The circuit level simulation plays a vital role in any electronic device modelling. The performance analysis of nano-level circuits is becoming quite challenging through simulation due to the existing environmental circumstances. Predicting or analysing the functional performance variations earlier in the circuit design cycle may increase the overall yield. This aspect depends mainly on the capability of simulation tools. By integrating ML/DL algorithms in



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CAD tools, the chip's performance and turnaround time can be restored with minimal design modifications [22]. Recently, researchers have proposed various methodologies for characterizing the power leakage, propagation delay and accurate estimation of IR drop levels. Different ML/DL are now analysed for its suitable implementation in the process of circuit modelling, including the techniques such as ANNs, Response Surface Modelling (RSM) and other ensemble techniques.

Architecture Level

More dynamic VLSI architectures are developed with the introduction of AI/ML techniques. Different AI based architectures have enhanced the VLSI technology [23]. The integration of neural network algorithms in semiconductor design helps to achieve higher bandwidth with enhanced performance. VLSI design improvements and adjustments are done for satisfying the requirements of implementing edge applications with enhanced reliability, high processing speed, reduced implementation cost and time. The AI based VLSI architectures are now predominantly used in various applications such as signal and speech processing, Internet of Things (IoT) models and automobiles. The evolving techniques include, DNN based memory architecture (near memory and data processing), introducing DNN models for ensuring synchronous flow of data from memory to the systolic arrays [24].

System Level

The deep learning capability is now influencing significant modifications in the System-on-Chip (SoC) architecture. ML/DL models introduce novel processing technologies with large-scale computations, advanced memory architecture, and high-speed connectivity. AI based SoC models have the ability ensure the IC operations in memory-constrained architectures present in mobile phones, automobiles, and IoT- Communication applications [25]. Field Programmable Gate Array (FPGA) is the well-known and widespread programmable circuit devices that accelerate and implement AI technologies on hardware. Digital modules such as Digital Signal Processing (DSP) models, ALUs and digital multipliers are easily and efficiently implemented using Neural Network (NN) models. The primary advantage of integrating Neural Networks (NNs) is its ability to efficiently realize high-speed circuits without considering the increasing number of components in the circuit. NNs can also maintain a trade-off between the off-chip(external) and internal memory [26]. Despite the hype, DL based SoC architectures are still remaining in the nascent stage with integrated processors and memory architectures. More research works will be initiated in this evolving domain the near future.

Physical Design Level

The physical design process of VLSI circuits have various combinatorial challenges, which usually requires many iterations to reach the solution. Scaling process will also increase the circuit design complexity with more Design for Manufacturing (DFM) challenges. Traditionally, the manual correction and fixing solutions are used. However, these manual methods fail to satisfy the market requirements. Also, in the next stage, the circuit design becomes more sensitive to the environment challenges. To combat these challenges, machine learning techniques enable quality physical design and at different abstraction levels. Recently, the transferrable chip operations and its representations are done by using Reinforcement Learning (RL) model [27]. Machine learning techniques are used to analyse the data-path benchmarks. AI based EDA tools are used to enhance the process of clock tree synthesis. The automated results produced by CNN is used to revolutionize the VLSI design cycle and performance. In particular, the neural networks architecture is used to report the valuable feedback as well as the solutions for solving various modelling complexities at different physical design stages.

Challenges and Opportunities for ML/DL in VLSI

At present, the utilization of computationally efficient methodologies to estimate an output based on the inputs is gaining a significant research interest in the domain VLSI CAD based circuit modelling. To enhance the yield and reliability, the VLSI design must be tuned optimally for enabling low power dissipation, reduce circuit dimension and achieving higher throughput [28]. In future, more fast and accurate device estimation techniques are required





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during the circuit design and modelling process. The exiting models verifies only the effect of process variations to improve the yield, further to guarantee the enhanced design quality, the dominant parameters that cause process variations should be identified. The analysis of the VLSI models' sub system behaviour plays a crucial role in its implementation. The introduction of ML/DL approach can increase the statistical rate of analysis of any memory designs. AI frameworks are used to implement high-level dynamic digital circuits in real-time hardware modules.

NNs can be used in embedded automation models found in IoT sensor modules, automobiles, cameras, etc. which require high speed classifiers and accelerators. Most importantly, the cost involved in testing a VLSI chip can be greatly reduced by integrating AI algorithms [29]. Integrating and implementing these state-of-the-art techniques in the design flow of VLSI is potential challenge for the CAD designers. The major challenges for the designers is the lack of availability of licensed DL/ML algorithms with debugging codes. However, implementation generating high-yield can be achieved by critically integrating ML/DL knowledge in CAD designers [30]. The limited availability of data can be extended id the data flow process is efficiently captured and processed. The microchip manufacturing industries need to explore more about the introduction of distributed systems for monitoring microchip workflows and enable more data and model driven optimizations to enhance the design quality [31].

CONCLUSION & FUTURE SCOPE

The ML/DL techniques will help to overcome various challenges in the IC industry. Even though, there are various existing methods to design, develop and test VLSI circuits, a proper and systematic way to enable design workflows still remains as a challenge. Developing a well-structured methodology with automated data processing capabilities using ML/DL algorithms at different IC design levels resolve the challenges to a greater extent. Nevertheless, the VLSI domain will face challenges while training the EDA tools and models with its limited data availability. Future advances in different ML/DL programming and quantum computing based methods have the potential to result in significant improvements in the EDA industry.

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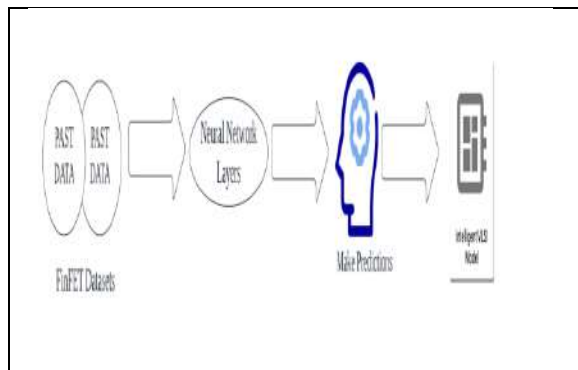


Figure 1: Introduction of ML/DL in Chip Design Process

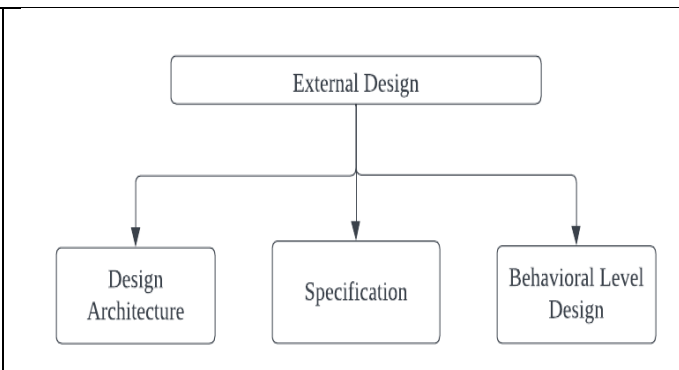


Figure 2: External Design Flow of VLSI Chip

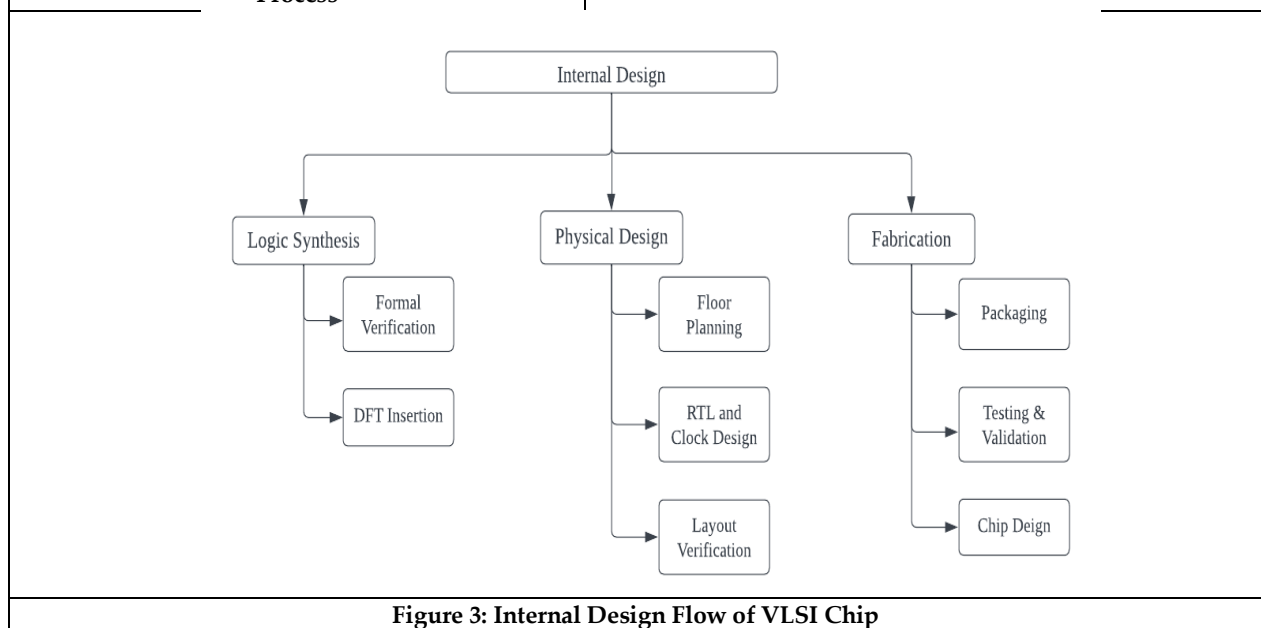


Figure 3: Internal Design Flow of VLSI Chip





IoT based Automatic Water Level Monitoring and Controlling System

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ABSTRACT

Yet just 3% of the water is fresh water suited for human consumption, despite the fact that 70% of the earth's surface is covered by water. Also, due to the expanding urban population, water conservation is essential in the modern environment. Most of the time, water spills when filling the overhead tanks, causing severe water loss for regular human needs. In order to address this issue, the IoT plays a major role to effectively utilize the water. Smart Water Level Controlling System [WLCS] was built on the Internet of Things and mobile devices has been developed to reduce the water wastage. This model can be used in any environments that can assist the wastage of liquid resources. This efficiently reduces water loss by keeping track of the volume of water in the overhead tank of home and notifying the user. This method makes it very comfortable for the user to regulate the system via mobile phone, preventing water loss from overhead tank overflow and also underflow. The total model can be monitored and operated using mobile phone or the web that includes the usage of water, level of water, leakage of water and also the other parameters like temperature etc.

Keywords: Internet of Things, Cloud, IoT Node, Sensors, M2M





INTRODUCTION

Water distribution is one of the concerns that receive less attention in metropolitan environments. Water-related problems abound, but one minor one is conflict between residents in flats over access to water that meets their needs. Water is the primary element used in daily living, whether for home or commercial purposes. Our ecology is being negatively impacted by excessive water waste. Water shortages brought on by excessive wasting may trigger a variety of environmental issues, including droughts, climate change, rising pollution, and increased human demand. It is crucial to use and manage water properly because fresh water is not readily available in large quantities. It is vital to keep a watch on water waste in all areas, including residential, commercial, and industrial setups. There is an immediate need to have an eye on the wastage of water across various sectors. This project's goal is to create an automatic water tank level and pump control system that has a variety of features for controlling the water pump in accordance with the amount of water in the storage tank system. An ultrasonic sensor positioned on the storage tank is utilized to detect the water level. This sensor is used to determine when the water level in the overhead tank is higher or lower. Node MCU controller is used to automate the process of pumping water to the overhead storage tank. In accordance with the information received, it operates the sensors that measure the water level and turns on and off the pump.

1. To design an automatic water tank level mechanism monitoring and to control the level of water quantity in the tank.
2. To keep track of the water level in the tank, which determines how much water is stored inside, to determine if it drops below a predetermined level while the motor is on and rises when it is off, eventually rises when the water is cut off.
3. To display the state of pump, levels of water and the level of main tank
4. To ON/OFF automatically by monitoring the water level in the main tank.

In most recent years, the adoption of internet and its applications has expanded quickly. Without the internet, it would be challenging because everyone depends on it for their profession. Moreover, wireless sensor networks—low power gadgets comprising a processor, storage, power supply, a transmitter, and one or more sensors—are becoming commonly employed. In this project, we will integrate these two in order to collect data from the aquatic environment, present it on the website, and do so utilizing wireless networks. A network of locally intelligent devices (such as sensors and actuators) known as the "Internet of Things" (IoT) shares control mechanisms to push and pull status and command information from the networked world. Internet of Things, then, refers to a network of physical devices that may collect data from sensors and transmit it to a server or computer across a network. The Machine to Machine (M2M) communication, which is capable of communication without human intervention, is also closely tied to the Internet of Things. This paper will define the system that will channel water from the first to the final user in the utilized environments. The primary reason for using IOT is its global networking capability to automatically control and monitor the level of the overhead tank without the need for human involvement. Also, by connecting to the Blynk server, we can monitor and operate the complete system from anywhere in the globe.

LITERATURE REVIEW

The authors in [1] offered a concept for a water level monitoring system that incorporates a PIC microcontroller and an LCD screen to alert the person in responsibility. The water level is continuously monitored, and when it reaches the critical level, the data is displayed on the LCD display panel. To reduce the possibility of water scarcity in the water supply, the system has been checked for proper operation. In paper [2] the researchers offered a concept of water level management using ultrasonic sensor (automation) to determine the level of the water and displaying on the LCD screen using ultrasonic sensor. The paper [3] proposed the design of monitoring system of the water level with an incorporation of GSM module which is too vigilant to the person in-charge by the help of Short Message Service (SMS). The water level is continuously monitored, and information about the issue has been sent via SMS to the appropriate in-charge phone. To reduce the possibility of water scarcity in the water supply, the system has been



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checked for proper operation. This notion of the PLC ground automated operation of detection of water in monitoring & distribution system was put forth in [4]. It enables us to detect the water monitoring automatically in accordance with the usage in specific locations. In [5] the authors proposed the Automatic water tank level monitoring and controlling system using Arduino uno board the system automatically controls the levels of water preventing the overflow from the overhead tank and controls the pump if the level of water is below the determined margin in the overhead tank. The authors in [6] proposed the indication of the water level with LED'S using Arduino uno. The red light used to indicate the water is about to finish and the green light used to represent that water in the tank is about to fill. Here we are using the IoT based system for controlling and monitoring of the water or any liquid crystals that makes more interactive interface to be operated.

Proposed Model

The goal of this work is to implement an automated water tank and pump to control the system that automatically regulates water/liquid levels to avoid overflow from the overhead tank and controls the pump if the level of water/liquid is below the established margin in the overhead tank. In this project, we have extended the water level monitoring and control by using the cloud platform and internet as shown in fig.1. There is possibility of multi-device connected by using Blynk apps and open ended cloud platforms. By using Blynk, the device can be monitored and controlled using mobile device and web control across the globe. The sensing part of the performing system includes ultrasonic sensor. The sensing information is being given to Node MCU. The Node MCU is configured to turn on the pump and buzzer automatically when the water/liquid level falls below a certain threshold. As the water/liquid level drops below the set level, the buzzer begins to buzz in high frequency. The controller activates the pump when the water/liquid level reaches the crucial level, and it begins pumping the liquid. The water/liquid will continue to be pumped and the tank will continue to fill without any issues. The water/liquid buzzes with a low frequency sound when it reaches a predetermined maximum level, and the pump turns off automatically if the tank is full.

Experimental Setup and Results

This system can monitor the level of water just by using our mobile phone from anywhere in the world. The only thing that we need is a Wi-Fi network in the vicinity of our tank. We made this project using a Node MCU esp8266 Wi-Fi module, ultrasonic sensor, and Blynk app. On the top of the water container lid, we place an ultrasonic sensor to read the level of the water container. The ultrasonic sensor is used for distance measurement by sending ultrasonic waves. The basic principle of ultrasonic distance measurement is based on ECHO. When sound waves are transmitted in environment, they return back to the origin as ECHO after striking on any obstacle. The only calculation of this system is the traveling time of both sound waves (outgoing time and returning time to origin after striking on any obstacle). And after few calculations it is possible to get the results Node MCU processes the data and gives us the data of water level and valve/pump status is saved with a timestamp. Each and every data obtained from the node has its timestamp and the Microcontroller node (Node MCU) transmits data to the Blynk server. The Blynk server also provides configuration information to the microcontroller. Water container height, Max upper-level limit, lower-level limit, mode, and on/off the pump are configuration parameters that are broken down into two modes, auto and semi-auto. If the water level is below the lower-level limit and the pump/valve is in automatic mode, the water will automatically fill the container and stop when it reaches the upper level limit or is equal to it.

In semi-auto mode, the microcontroller operates like auto mode if on/off is in the on position, but if on/off is in the off position, the pump or valve will remain off until on/off is in the on position. Also, we can use a relay module in order to control the motor to fill the tank, sitting anywhere in the world. We can not only just monitor the water level but also (control the Water level) fill the tank from anywhere in the world as shown in fig.2. The different parameters for the water tank like max level of tank, min level of tank, threshold value and also the total capacity of water tank are considered for the evaluation of the work for automatic controlling and monitoring of water tank from anywhere and any place. Table 2 describes the pump on/off scenario and also the status of the buzzer. The flow chart of the



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proposed model is given below. The proposed experimental setup was given in fig.3 and fig.4. The water level usage and tank liquid level and temperature of the liquid are given in fig.6, fig.7 and fig.8. The readings can be observed in cloud and Blynk app as shown in fig.3 and fig.5.

Algorithm

Step 1: Firstly, we want to establish a stable private Wi-fi connection to the existing Node MCU System and create a private Blynk server application interface and connect mobile and multiple devices to the connected server.

Step 2: Now pull the data values and measure the distance (height of the water level) by using ultrasonic sensor.

Step 3: Now compare the Water level with the constraint values of MAX and MIN values from the initial values declarations in the code dumped in the Node MCU.

Step 4: If the value of water level is less than the minimum value ($\text{Water level} < \text{MIN}$) then buzzer gets buzzes with high frequency of sound and automatically Motor also gets ON.

Step 5: Else if water level is in between the max and min value ($\text{MAX} \leq \text{Water level} \leq \text{MIN}$) then buzzer gets OFF, but the motor is still in ON mode.

Step 6: Else water level is greater than max value ($\text{Water level} > \text{MAX}$) then the buzzer gets ON and the pump motor Gets turned OFF.

Step 7: The temperature and pressure of the liquid is also observed.

CONCLUSIONS

Here, we created a circuit that uses IOT to control and track the water level in an above tank. Also, it reduces the issue of water waste brought on by improper home monitoring. The essential components are a Wi-Fi device, a Node MCU, and an ultrasonic sensor. To begin with, it must be determined whether our module is linked to Wi-Fi. If connected, it will immediately display the water level on any web-linked devices (mobile) or in the web. It regularly checks the tank's water level. To prevent water loss, the water pump will automatically start if the level exceeds the lower limit that has been established and cease when it reaches the higher limit of the tank. The model is designed in such a way that it saves electricity, cost, and mostly reduces the traditional water overflow challenges. In future we are planning to extend the system with water quality and also the predictive analysis of water usage at a particular scenario.

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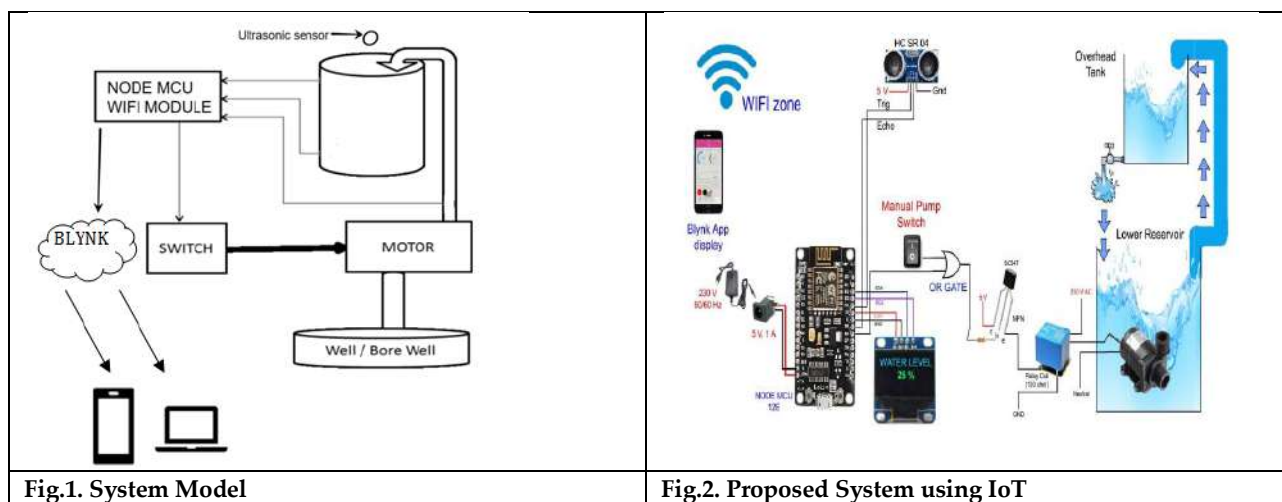
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Table 1: Hardware and Software Components

SL.NO	TYPE	Description
1	HARDWARE REQUIREMENTS	NODEMCU
		Relay module
		5V Motor
		Buzzer
		Battery
		Ultrasonic Sensor
		Connecting Wires
2	SOFTWARE REQUIREMENTS	Arduino IDE
		Blynk App & Server

Table2. Different levels of Water indication table

SL. No	Water level	Buzzer Status	Pump/Motor Status
1	Min	ON (HIGH FREQUENCY)	ON
2	Min<Water Level<Max	OFF	ON
3	Max	ON (LOW FREQUENCY)	OFF



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Fig.3. Experimental setup



Fig.4. System Prototype

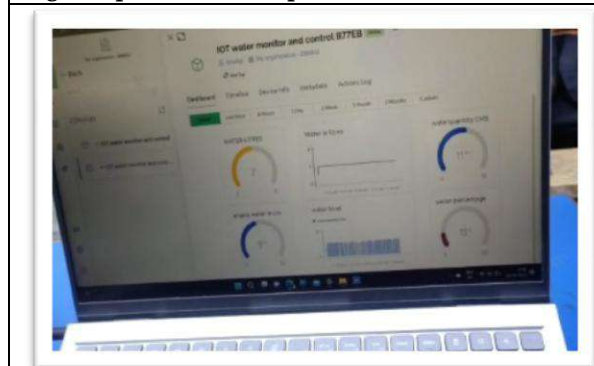


Fig.5. Cloud based representations

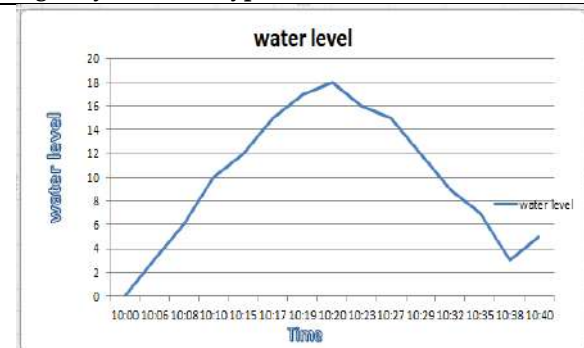


Fig.6. Timestamp based water level usage

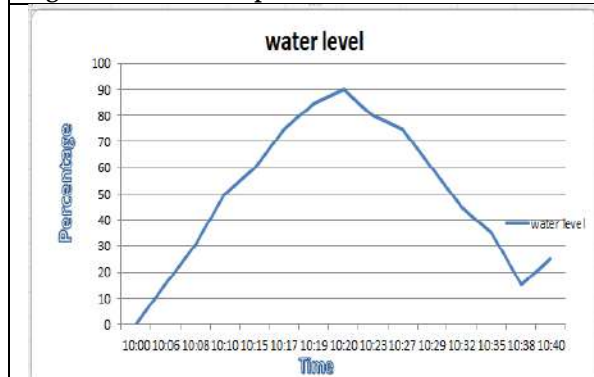


Fig.7. Water Usage

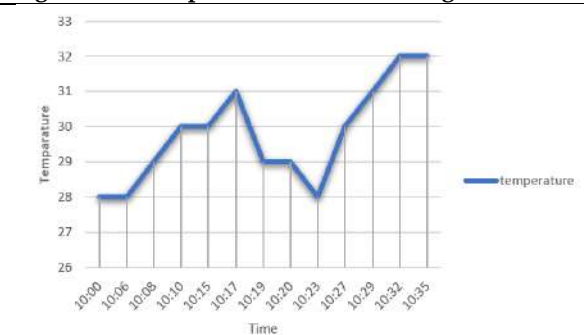


Fig.8. Liquid temperature





Generalized Inverse of Centrosymmetric and K-Centrosymmetric 2×2 Neutrosophic Fuzzy Matrices

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ABSTRACT

A method for finding the generalized inverse of Centrosymmetric and k-Centrosymmetric Neutrosophic Fuzzy Matrices is provided in this paper. We discussed various g-inverse associated with a regular Neutrosophic Fuzzy Matrices and obtain characterization of set of all inverses by using Centrosymmetric and K-Centrosymmetric Neutrosophic Fuzzy Matrices. We proved sum, product and scalar multiplication of two Centrosymmetric Neutrosophic Fuzzy Matrices is again a Centrosymmetric Neutrosophic Fuzzy Matrices and also focusing on the fundamental principles and theorems of Centrosymmetric and k-Centrosymmetric Neutrosophic Fuzzy Matrices, as well as examples.

Keywords: Centrosymmetric NFM, k-Centrosymmetric NFM, Generalized inverse.

INTRODUCTION

Zadeh [1] first introduced fuzzy sets (FSs) in 1965. These are traditionally defined by their membership value or grade of membership. Assigning membership values to a fuzzy set can sometimes be challenging. Atanassov [2] introduced intuitionistic FSs to solve the problem of assigning non-membership values. Smarandache [3] introduced the concept of neutrosophic sets (NSs) to handle indeterminate information and deal with problems that involve imprecision, uncertainty, and inconsistency. Fuzzy matrices are used to solve certain kinds of issues. Many researchers have since completed numerous works. Only membership values are addressed by fuzzy matrices. These matrices cannot handle values that are not membership. The generalized inverse (g-inverse) deals with matrix inverse generalization for both singular and non-square matrices Kim and Roush [8] have discussed Generalized





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fuzzy matrices. Pradhan and Pal [10] have studied The Generalized Inverse of Atanassov's IFM. Pradhan and Pal [11] have studied Some results on Generalized Inverse of IFM. The generalized inverse of matrices is applicable in many field, likely power, robotics, image processing and signal processing. Ann Lec [1] has introduced Secondary symmetric and skew symmetric secondary orthogonal matrices. Cantoni and Butler [2] have studied Eigenvalues and eigenvectors of symmetric centrosymmetric matrices. James Weaver [7] has discussed Centrosymmetric matrices their basic properties eigen values and eigenvectors. Punithavall [12] has studied Symmetric-Centro Symmetric Fuzzy Matrices. Elumalai and Rajesh kannan [3] have focused on k - Symmetric Circulant, s - Symmetric Circulant and s – k Symmetric Circulant Matrices. Elumalai and Arthi [4] have studied Properties of k - CentroSymmetric and k – Skew CentroSymmetric Matrices.

Gunasekaran Mohana [5] have studied k-symmetric Double stochastic, s-symmetric Double stochastic, s-k-symmetric Double stochastic Matrices. Hazewinkel and Michiel [6] have focused on Symmetric matrix. Meenakshi [9] has studied Fuzzy Matrix: Theory and Applications. Anandhkumar [13,14,15] has studied Pseudo Similarity of NFM, On various Inverse of NFM and Reverse Sharp And Left-T Right-T Partial Ordering On NFM. Aim of this paper is to describe generalized inverse of Centrosymmetric, k- Centrosymmetric Intuitionistic Fuzzy Matrices and to discuss some basic principles and theorems of Centrosymmetric and k- Centrosymmetric matrices, as well as examples.

Research Gap

Punithavalli presented the concept of Centrosymmetric and K-Centrosymmetric Fuzzy Matrices. Here, we have applied the concept of Centrosymmetric and K-Centrosymmetric 2×2 Neutrosophic Fuzzy Matrices. We have examined some of the results and extended both concepts to NFMs. We discussed various g-inverse associated with a regular matrices and obtain characterization of set of all inverses by using Centrosymmetric and K-Centrosymmetric NFM.

Preliminaries and notations

P^T is the Transpose of P if P is a Centrosymmetric NFM. Let k denote a fixed distinct transposition product in S_n and K represent the permutation NFM. Clearly K meets characteristics like $K^T = K$ and $K^2 = I$.

Definitions and theorems

Definition:1.1 Centrosymmetric NFM(CSNFM): A Square NFM which is symmetric about the centre of its array of elements is called CS, thus $P = [p_{ij}]$ CS if $p_{ij} = p_{n-i+1, n-j+1}$. If K denotes the $n \times n$ NFM with $\langle 1, 1, 0 \rangle$ on the counterdiagonal and $\langle 0, 0, 1 \rangle$ everywhere else (i.e. $K_{i, n+1-i} = \langle 1, 1, 0 \rangle$; $K_{i, j} = \langle 0, 0, 1 \rangle$ if $j \neq n+1-i$), then P is CSNFM iff $PK = KP$.

Example:1 Let us consider the IFM

$$P = \begin{bmatrix} \langle 0.7, 0.2, 0.4 \rangle & \langle 0.4, 0.2, 0.3 \rangle \\ \langle 0.4, 0.2, 0.3 \rangle & \langle 0.7, 0.2, 0.4 \rangle \end{bmatrix} \text{ and } K = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$$

$$\text{Then } PK = \begin{bmatrix} \langle 0.4, 0.8, 0.3 \rangle & \langle 0.7, 0.8, 0.4 \rangle \\ \langle 0.7, 0.8, 0.4 \rangle & \langle 0.4, 0.8, 0.3 \rangle \end{bmatrix}, KA = \begin{bmatrix} \langle 0.4, 0.8, 0.3 \rangle & \langle 0.7, 0.8, 0.4 \rangle \\ \langle 0.7, 0.8, 0.4 \rangle & \langle 0.4, 0.8, 0.3 \rangle \end{bmatrix}.$$

Definition: 1.2 If P Centrosymmetric Neutrosophic Fuzzy matrices (NFM) $P \in (NFM)_n$ is called k-Centrosymmetric NFM if $P = KP^TK$

Definition 1.3 Suppose p and q are two NFM elements $p = \langle p_{ij\alpha}, p_{ij\beta}, p_{ij\gamma} \rangle$, $q = \langle q_{ij\alpha}, q_{ij\beta}, q_{ij\gamma} \rangle$, are component wise addition and multiplication are described as,





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$$p + q = \langle \max \{p_{ij\alpha}, q_{ij\alpha}\}, \max \{p_{ij\beta}, q_{ij\beta}\}, \min \{p_{ij\gamma}, q_{ij\gamma}\} \rangle$$

$$\text{and } p \cdot q = \langle \min \{p_{ij\alpha}, q_{ij\alpha}\}, \min \{1 - p_{ij\beta}, 1 - q_{ij\beta}\}, \max \{p_{ij\gamma}, q_{ij\gamma}\} \rangle$$

Definition 1.4 (Transpose) The transpose P^T of an NFM $P = [p_{ij}]_{m \times n}$ is defined as $P^T = [p_{ji}]_{n \times m}$ where $p_{ji} = \langle p_{ji\alpha}, p_{ji\beta}, p_{ji\gamma} \rangle$.

Definition 1.5 (IFPM) If each row and each column contains accurately one $\langle 1, 1, 0 \rangle$ and all other entries are $\langle 0, 0, 1 \rangle$ in a square NFM, it is known as intuitionistic Fuzzy permutation matrix.

Definition 1.6 A basis D of an intuitionistic fuzzy vector space W is standard basis iff whenever $d_i = \sum_{j=1}^n a_{ij} d_j$ for

$$d_i, d_j \in D \text{ and } a_{ij} \in [0, 1] \text{ then } a_{ij} d_i = d_i$$

Generalized Inverse

This section shows the g-inverse of an NFM. We also described a method for finding the g-inverse of a Centrosymmetric and k-Centrosymmetric NFMs.

Definition: 2.1 For NFM $P \in (NFM)_{m \times n}$ and another NFM $K \in (NFM)_{n \times m}$ satisfies the given equation

- (i) $PKP = P$ (g-inverse)
- (ii) $KPK = K$ (2-inverse)
- (iii) $(PK)^T = PK$, (Least square g-inverse of P or $P\{1, 3\}$ inverses)
- (iv) $(KP)^T = KP$, ($P\{1, 4\}$ inverses).

Theorem: 1 Let P be a Centrosymmetric NFM with a standard basis of non-zero rows. If P satisfies the equation $PKP = P$ with the maximum and minimum process for some NFPMK, then K is a generalized inverse of P .

Proof: A standard basis is formed by the non-zero rows of an NFM P .

If $KP = Z$, Therefore the rows of Z and the rows of P rearranged.

Then Z is an idempotent NFM,

i.e., $Z = Z^2$, with the similar row space as P and non-zero rows forming a standard basis as well. Therefore the standard basis is unique,

$\Rightarrow P = ZK$, where K is permutation matrix.

Therefore,

$$PK^T P = ZKK^T ZK$$

$$= ZK \quad (KK^T = I)$$

$$= ZK$$

$$= P$$

$$PKP = P \quad (K^T = K)$$

Therefore, K is 2-inverse.

Example: 2 Consider the NFM, $P = \begin{bmatrix} \langle 0.6, 0.2, 0.4 \rangle & \langle 0.8, 0.2, 0.3 \rangle \\ \langle 0.8, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \end{bmatrix}$, $K = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$

$$KP = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix} \begin{bmatrix} \langle 0.6, 0.2, 0.4 \rangle & \langle 0.8, 0.2, 0.3 \rangle \\ \langle 0.8, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \end{bmatrix} = \begin{bmatrix} \langle 0.8, 0.8, 0.3 \rangle & \langle 0.6, 0.8, 0.4 \rangle \\ \langle 0.6, 0.8, 0.4 \rangle & \langle 0.8, 0.8, 0.3 \rangle \end{bmatrix}$$





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$$PKP = \begin{bmatrix} \langle 0.6, 0.2, 0.4 \rangle & \langle 0.8, 0.2, 0.3 \rangle \\ \langle 0.8, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \end{bmatrix} \begin{bmatrix} \langle 0.8, 0.8, 0.3 \rangle & \langle 0.6, 0.8, 0.4 \rangle \\ \langle 0.6, 0.8, 0.4 \rangle & \langle 0.8, 0.8, 0.3 \rangle \end{bmatrix}$$

$$PKP = \begin{bmatrix} \langle 0.6, 0.2, 0.4 \rangle & \langle 0.8, 0.2, 0.3 \rangle \\ \langle 0.8, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \end{bmatrix}$$

Theorem:2 For Centrosymmetric NFM $Q \in F_n$, if Q^+ exists $\Leftrightarrow (KQ)^+$ exists.

Proof : For Centrosymmetric NFM $Q \in F_n$, if Q^+ exists then $Q^+ = Q^T$

$\Rightarrow Q^T$ is a generalized inverse of Q , then $QQ^TQ = Q \Rightarrow Q^TQQ^T = Q^T$

Therefore, Q^T is a $\{2\}$ inverse of Q .

Since both QQ^T and Q^TQ are symmetric.

Hence $Q^+ = Q^T$

Q^+ exists $\Leftrightarrow QQ^TQ = Q$

Q^+ exists $\Leftrightarrow KQQ^TQ = KQ$

Q^+ exists $\Leftrightarrow (KQ)(KQ)^T(KQ) = KQ$ where $K^2 = I$

Q^+ exists $\Leftrightarrow (KQ) \in (KQ)\{1\}$

$\Leftrightarrow (KQ)^+$ exists

Example:3 Consider the IFM, $Q = \begin{bmatrix} \langle 0.8, 0.2, 0.4 \rangle & \langle 0.6, 0.3, 0.4 \rangle \\ \langle 0.6, 0.3, 0.4 \rangle & \langle 0.8, 0.2, 0.4 \rangle \end{bmatrix}$, $K = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$

Theorem:3 If $P \in (NFM)_n$ is k-Centrosymmetric NFM, then K is a least square g- inverse of P .

Proof : It is enough to show

I. $PKP = P$

II. $(PK)^T = PK$

By theorem (1), (i) is easily verified

Let $P \in (NFM)_n$ is K-centrosymmetric NFM

$P = KP^TK$

$PK = KP^TK.K$

$PK = KP^TK^2$ ($K^2 = I$)

$PK = KP^TI = KP^T$

$(PK)^T = K^TP^T = KP^T$ ($K^T = K$)

$(PK)^T = KP^T$

Therefore, $(PK)^T = PK$

Example: 4

Let us consider the NFM, $P = \begin{bmatrix} \langle 0.8, 0.1, 0.4 \rangle & \langle 0.6, 0.3, 0.4 \rangle \\ \langle 0.6, 0.3, 0.4 \rangle & \langle 0.8, 0.1, 0.4 \rangle \end{bmatrix}$, $K = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$

$$PK = \begin{bmatrix} \langle 0.8, 0.1, 0.4 \rangle & \langle 0.6, 0.3, 0.4 \rangle \\ \langle 0.6, 0.3, 0.4 \rangle & \langle 0.8, 0.1, 0.4 \rangle \end{bmatrix} \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix} = \begin{bmatrix} \langle 0.6, 0.9, 0.4 \rangle & \langle 0.8, 0.7, 0.4 \rangle \\ \langle 0.8, 0.7, 0.4 \rangle & \langle 0.6, 0.9, 0.4 \rangle \end{bmatrix}$$





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$$(PK)^T = \begin{bmatrix} \langle 0.6, 0.9, 0.4 \rangle & \langle 0.8, 0.7, 0.4 \rangle \\ \langle 0.8, 0.7, 0.4 \rangle & \langle 0.6, 0.9, 0.4 \rangle \end{bmatrix}$$

Theorem:4 If $P \in (NFM)_n$ is k-Centrosymmetric NFM, then K is a $\{1,4\}$ generalized inverse of P.

Proof : It is enough to show

$$(i) \quad PKP = P$$

$$(ii) \quad (KP)^T = KP$$

By theorem (1), (i) is easily verified

Let $P \in (NFM)_n$ is K-Centrosymmetric matrix

$$P = KP^T K$$

$$K = K.KP^T K$$

$$KP = K^2 P^T K \quad (K^2 = I)$$

$$KP = KP^T K = P^T K$$

$$(KP)^T = P^T K^T = P^T K \quad (K^T = K)$$

$$(KP)^T = P^T K$$

$$\text{Therefore, } (KP)^T = KP$$

Example:5

Consider the IFM, $P = \begin{bmatrix} \langle 0.5, 0.1, 0.2 \rangle & \langle 0.4, 0.1, 0.7 \rangle \\ \langle 0.4, 0.1, 0.7 \rangle & \langle 0.5, 0.1, 0.2 \rangle \end{bmatrix}$, $K = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$

Centrosymmetric Neutrosophic Fuzzy Matrix

This part, depicts the Centrosymmetric of an NFM.

Lemma: If P and Q are Centrosymmetric NFM over a field F, then P + Q, PQ, and cP are Centrosymmetric NFM for all c in F.

Proof: By using definition:1

Example:6

Consider the IFM $P = \begin{bmatrix} \langle 0.6, 0.2, 0.4 \rangle & \langle 0.8, 0.2, 0.3 \rangle \\ \langle 0.8, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \end{bmatrix}$, $Q = \begin{bmatrix} \langle 0.8, 0.8, 0.3 \rangle & \langle 0.6, 0.8, 0.4 \rangle \\ \langle 0.6, 0.8, 0.4 \rangle & \langle 0.8, 0.8, 0.3 \rangle \end{bmatrix}$

$$P + Q = \begin{bmatrix} \langle 0.6, 0.2, 0.4 \rangle & \langle 0.8, 0.2, 0.3 \rangle \\ \langle 0.8, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \end{bmatrix} + \begin{bmatrix} \langle 0.8, 0.8, 0.3 \rangle & \langle 0.6, 0.8, 0.4 \rangle \\ \langle 0.6, 0.8, 0.4 \rangle & \langle 0.8, 0.8, 0.3 \rangle \end{bmatrix}$$

$$= \begin{bmatrix} \langle 0.8, 0.8, 0.3 \rangle & \langle 0.8, 0.8, 0.3 \rangle \\ \langle 0.8, 0.8, 0.3 \rangle & \langle 0.8, 0.8, 0.3 \rangle \end{bmatrix}$$

Therefore, A+B is centrosymmetric

$$PQ = \begin{bmatrix} \langle 0.6, 0.2, 0.4 \rangle & \langle 0.8, 0.2, 0.3 \rangle \\ \langle 0.8, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \end{bmatrix} \begin{bmatrix} \langle 0.8, 0.8, 0.3 \rangle & \langle 0.6, 0.8, 0.4 \rangle \\ \langle 0.6, 0.8, 0.4 \rangle & \langle 0.8, 0.8, 0.3 \rangle \end{bmatrix}$$

$$PQ = \begin{bmatrix} \langle 0.6, 0.2, 0.4 \rangle & \langle 0.8, 0.2, 0.3 \rangle \\ \langle 0.8, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \end{bmatrix}$$

Therefore, AB is centrosymmetric





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$$cA = \begin{bmatrix} \langle 0.7, 0.2, 0.3 \rangle & \langle 0.4, 0.6, 0.5 \rangle \\ \langle 0.4, 0.6, 0.5 \rangle & \langle 0.7, 0.2, 0.3 \rangle \end{bmatrix} = \begin{bmatrix} \langle 0, 0.8, 1 \rangle & \langle 0, 0.4, 1 \rangle \\ \langle 0, 0.4, 1 \rangle & \langle 0, 0.8, 1 \rangle \end{bmatrix}$$

Therefore, cA is centrosymmetric

K-Centrosymmetric Neutrosophic Fuzzy Matrix

This part, depicts the K- Centrosymmetric matrices of an NFM.

Theorem: 5 Let $P \in (NFM)_n$ is k-Centrosymmetric NFM then $P^T = KPK$.

Proof: Let $P \in (NFM)_n$ is k-Centrosymmetric NFM

$$KPK = KP^TK \text{ where } P = P^T$$

$$= P^TKK \text{ where } KP^T = P^TK$$

$$= P^TK^2 = P^T$$

Example:7 Consider the IFM $P = \begin{bmatrix} \langle 0.7, 0.2, 0.4 \rangle & \langle 0.4, 0.2, 0.5 \rangle \\ \langle 0.4, 0.2, 0.5 \rangle & \langle 0.7, 0.2, 0.4 \rangle \end{bmatrix}$, $K = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$

$$AK = \begin{bmatrix} \langle 0.7, 0.2, 0.4 \rangle & \langle 0.4, 0.2, 0.5 \rangle \\ \langle 0.4, 0.2, 0.5 \rangle & \langle 0.7, 0.2, 0.4 \rangle \end{bmatrix} \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix} = \begin{bmatrix} \langle 0.4, 0.8, 0.5 \rangle & \langle 0.7, 0.8, 0.4 \rangle \\ \langle 0.7, 0.8, 0.4 \rangle & \langle 0.4, 0.8, 0.5 \rangle \end{bmatrix}$$

$$KAK = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix} \begin{bmatrix} \langle 0.4, 0.8, 0.5 \rangle & \langle 0.7, 0.8, 0.4 \rangle \\ \langle 0.7, 0.8, 0.4 \rangle & \langle 0.4, 0.8, 0.5 \rangle \end{bmatrix} = \begin{bmatrix} \langle 0.7, 0.2, 0.4 \rangle & \langle 0.4, 0.2, 0.5 \rangle \\ \langle 0.4, 0.2, 0.5 \rangle & \langle 0.7, 0.2, 0.4 \rangle \end{bmatrix}$$

$$KAK = A^T$$

Theorem: 6 If P, Q are both k-Centrosymmetric NFM, then PQ is as well.

Proof: P and Q are both k-Centrosymmetric NFM if $P = KP^TK$ and $Q = KQ^TK$.

We know that, P^T and Q^T are also k-Centrosymmetric NFM then $P^T = KPK$ & $Q^T = KQK$.

To prove PQ is k-Centrosymmetric NFM

It's enough to show, $PQ = K(PQ)^TK$

$$\text{Now } K(PQ)^TK = KQ^TKP^TK$$

$$= K[(KQK)(KPK)]K \text{ where, } P^T = KPK \text{ and } Q^T = KQK$$

$$= K^2 QK^2 P K^2 \text{ Properties of K-Centrosymmetric NFM,}$$

$$= QP$$

$$\text{Where } K^2 = I$$

$$= PQ \text{ Where, } PQ = QP$$

Example:8 Consider the NFM, $P = \begin{bmatrix} \langle 0.8, 0.2, 0.4 \rangle & \langle 0.6, 0.4, 0.2 \rangle \\ \langle 0.6, 0.4, 0.2 \rangle & \langle 0.8, 0.2, 0.4 \rangle \end{bmatrix}$, $K = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$ and

$$B = \begin{bmatrix} \langle 0.6, 0.4, 0.5 \rangle & \langle 0.7, 0.3, 0.6 \rangle \\ \langle 0.7, 0.3, 0.6 \rangle & \langle 0.6, 0.4, 0.5 \rangle \end{bmatrix}$$

$$PQ = \begin{bmatrix} \langle 0.8, 0.2, 0.4 \rangle & \langle 0.6, 0.4, 0.2 \rangle \\ \langle 0.6, 0.4, 0.2 \rangle & \langle 0.8, 0.2, 0.4 \rangle \end{bmatrix} \begin{bmatrix} \langle 0.6, 0.4, 0.5 \rangle & \langle 0.7, 0.3, 0.6 \rangle \\ \langle 0.7, 0.3, 0.6 \rangle & \langle 0.6, 0.4, 0.5 \rangle \end{bmatrix}$$





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$$\begin{aligned}
 &= \begin{bmatrix} \langle 0.6, 0.6, 0.5 \rangle & \langle 0.7, 0.7, 0.6 \rangle \\ \langle 0.7, 0.7, 0.6 \rangle & \langle 0.6, 0.6, 0.5 \rangle \end{bmatrix} \\
 (PQ)^T &= \begin{bmatrix} \langle 0.6, 0.6, 0.5 \rangle & \langle 0.7, 0.7, 0.6 \rangle \\ \langle 0.7, 0.7, 0.6 \rangle & \langle 0.6, 0.6, 0.5 \rangle \end{bmatrix} \\
 (PQ)^T K &= \begin{bmatrix} \langle 0.6, 0.6, 0.5 \rangle & \langle 0.7, 0.7, 0.6 \rangle \\ \langle 0.7, 0.7, 0.6 \rangle & \langle 0.6, 0.6, 0.5 \rangle \end{bmatrix} \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix} \\
 &= \begin{bmatrix} \langle 0.7, 0.4, 0.6 \rangle & \langle 0.6, 0.3, 0.5 \rangle \\ \langle 0.6, 0.3, 0.5 \rangle & \langle 0.7, 0.4, 0.6 \rangle \end{bmatrix} \\
 K(PQ)^T K &= \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix} \begin{bmatrix} \langle 0.7, 0.4, 0.6 \rangle & \langle 0.6, 0.3, 0.5 \rangle \\ \langle 0.6, 0.3, 0.5 \rangle & \langle 0.7, 0.4, 0.6 \rangle \end{bmatrix} \\
 &= \begin{bmatrix} \langle 0.6, 0.6, 0.5 \rangle & \langle 0.7, 0.7, 0.6 \rangle \\ \langle 0.7, 0.7, 0.6 \rangle & \langle 0.6, 0.6, 0.5 \rangle \end{bmatrix} \\
 K(PQ)^T K &= PQ
 \end{aligned}$$

Theorem: 7 If $P \in (NFM)$ is k -Centrosymmetric NFM then PP^T is likewise k -Centrosymmetric NFM.

Proof : Let $P \in (NFM)_n$ is said to be k -Centrosymmetric NFM, then $P = KP^T K$

If P^T also k -centrosymmetric NFM then $P^T = K P K$

To prove that, $PP^T = K(PP^T)^T K$

$$\begin{aligned}
 K(PP^T)^T K &= K[(P^T)^T P^T] K \\
 &= K[(PP^T)] K
 \end{aligned}$$

$$= (PP^T) K K$$

$$= (PP^T) K^2 \quad \text{Where } K^2 = I$$

$$= PP^T$$

Example:9

Consider the NFM, $P = \begin{bmatrix} \langle 0.4, 0.2, 0.3 \rangle & \langle 0.2, 0.4, 0.5 \rangle \\ \langle 0.2, 0.4, 0.5 \rangle & \langle 0.4, 0.2, 0.3 \rangle \end{bmatrix}$, $K = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$

$$\begin{aligned}
 PP^T &= \begin{bmatrix} \langle 0.4, 0.2, 0.3 \rangle & \langle 0.2, 0.4, 0.5 \rangle \\ \langle 0.2, 0.4, 0.5 \rangle & \langle 0.4, 0.2, 0.3 \rangle \end{bmatrix} \begin{bmatrix} \langle 0.4, 0.2, 0.3 \rangle & \langle 0.2, 0.4, 0.5 \rangle \\ \langle 0.2, 0.4, 0.5 \rangle & \langle 0.4, 0.2, 0.3 \rangle \end{bmatrix} \\
 &= \begin{bmatrix} \langle 0.4, 0.4, 0.3 \rangle & \langle 0.2, 0.6, 0.5 \rangle \\ \langle 0.2, 0.6, 0.5 \rangle & \langle 0.4, 0.4, 0.3 \rangle \end{bmatrix}
 \end{aligned}$$

$$(PP^T)^T = \begin{bmatrix} \langle 0.4, 0.4, 0.3 \rangle & \langle 0.2, 0.6, 0.5 \rangle \\ \langle 0.2, 0.6, 0.5 \rangle & \langle 0.4, 0.4, 0.3 \rangle \end{bmatrix}$$

$$(PP^T)^T K = \begin{bmatrix} \langle 0.4, 0.4, 0.3 \rangle & \langle 0.2, 0.6, 0.5 \rangle \\ \langle 0.2, 0.6, 0.5 \rangle & \langle 0.4, 0.4, 0.3 \rangle \end{bmatrix} \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$$





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$$\begin{aligned}
 &= \begin{bmatrix} \langle 0.2, 0.6, 0.5 \rangle & \langle 0.4, 0.4, 0.3 \rangle \\ \langle 0.4, 0.4, 0.3 \rangle & \langle 0.2, 0.6, 0.5 \rangle \end{bmatrix} \\
 K(P P^T)^T K &= \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix} \begin{bmatrix} \langle 0.2, 0.6, 0.5 \rangle & \langle 0.4, 0.4, 0.3 \rangle \\ \langle 0.4, 0.4, 0.3 \rangle & \langle 0.2, 0.6, 0.5 \rangle \end{bmatrix} \\
 K(P P^T)^T K &= \begin{bmatrix} \langle 0.4, 0.4, 0.3 \rangle & \langle 0.2, 0.6, 0.5 \rangle \\ \langle 0.2, 0.6, 0.5 \rangle & \langle 0.4, 0.4, 0.3 \rangle \end{bmatrix} \\
 K(P P^T)^T K &= P P^T
 \end{aligned}$$

Note: If $P \in (NFM)_n$ is k-Centrosymmetric NFM then P^2 is also k-centrosymmetric NFM.

Theorem:8 If $P \in (NFM)_n$ is k-centrosymmetric NFM then $P + P^T$ is also k-centrosymmetric NFM.

Proof : Let $P \in (NFM)_n$ is said to be k-Centrosymmetric NFM, then $P = K P^T K$

If P^T is also k-centrosymmetric NFM, then $P^T = K P K$

To prove that, $P + P^T = K(P + P^T)^T K$

$$K(P + P^T)^T K = K(P^T + (P^T)^T)K$$

$$= K(P^T + P)K$$

$$= (P^T + P)K.K$$

$$= (P^T + P)K^2$$

$$\text{Where, } K^2 = I$$

$$= (P^T + P) = (P + P^T)$$

Note: If $P \in (NFM)$ is k-centrosymmetric NFM then $A - A^T$ is likewise k-centrosymmetric NFM.

Example:10

Consider the NFM, $P = \begin{bmatrix} \langle 0.8, 0.2, 0.6 \rangle & \langle 0.2, 0.4, 0.7 \rangle \\ \langle 0.2, 0.4, 0.7 \rangle & \langle 0.8, 0.2, 0.6 \rangle \end{bmatrix}$, $K = \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$

Theorem:9 If P and Q are k-Centrosymmetric NFM then $P+Q$ is also k-Centrosymmetric NFM.

Proof : If both P and Q are k-centrosymmetric NFM if $P = K P^T K$ & $Q = K Q^T K$

Since P^T and Q^T are also k-Centrosymmetric NFM then $P^T = K P K$ and $Q^T = K Q K$.

To show that $P+Q$ is k-centrosymmetric NFM matrix

To prove that, $P+Q = K(P+Q)^T K$

$$\text{Now } K(P+Q)^T K = K(P^T + Q^T)K$$

$$= K P^T K + K Q^T K = P + Q$$

Example:11

Consider the NFM, $P = \begin{bmatrix} \langle 0.7, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \\ \langle 0.6, 0.2, 0.4 \rangle & \langle 0.7, 0.2, 0.3 \rangle \end{bmatrix}$, $B = \begin{bmatrix} \langle 0.4, 0.2, 0.6 \rangle & \langle 0.5, 0.3, 0.4 \rangle \\ \langle 0.5, 0.3, 0.4 \rangle & \langle 0.4, 0.2, 0.6 \rangle \end{bmatrix}$

$$\begin{aligned}
 A + B &= \begin{bmatrix} \langle 0.7, 0.2, 0.3 \rangle & \langle 0.6, 0.2, 0.4 \rangle \\ \langle 0.6, 0.2, 0.4 \rangle & \langle 0.7, 0.2, 0.3 \rangle \end{bmatrix} + \begin{bmatrix} \langle 0.4, 0.2, 0.6 \rangle & \langle 0.5, 0.3, 0.4 \rangle \\ \langle 0.5, 0.3, 0.4 \rangle & \langle 0.4, 0.2, 0.6 \rangle \end{bmatrix} \\
 &= \begin{bmatrix} \langle 0.7, 0.2, 0.3 \rangle & \langle 0.6, 0.3, 0.4 \rangle \\ \langle 0.6, 0.3, 0.4 \rangle & \langle 0.7, 0.2, 0.3 \rangle \end{bmatrix}
 \end{aligned}$$

$$(A + B)^T K = \begin{bmatrix} \langle 0.7, 0.2, 0.3 \rangle & \langle 0.6, 0.3, 0.4 \rangle \\ \langle 0.6, 0.3, 0.4 \rangle & \langle 0.7, 0.2, 0.3 \rangle \end{bmatrix} \begin{bmatrix} \langle 0, 0, 1 \rangle & \langle 1, 1, 0 \rangle \\ \langle 1, 1, 0 \rangle & \langle 0, 0, 1 \rangle \end{bmatrix}$$





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$$(A+B)^T K = \begin{bmatrix} \langle 0.6, 0.3, 0.4 \rangle & \langle 0.7, 0.2, 0.3 \rangle \\ \langle 0.7, 0.2, 0.3 \rangle & \langle 0.6, 0.3, 0.4 \rangle \end{bmatrix}$$

$$K(A+B)^T K = \begin{bmatrix} \langle 0.7, 0.2, 0.3 \rangle & \langle 0.6, 0.3, 0.4 \rangle \\ \langle 0.6, 0.3, 0.4 \rangle & \langle 0.7, 0.2, 0.3 \rangle \end{bmatrix}$$

$$K(P+Q)^T K = P+Q$$

Note: If P and Q are k -Centrosymmetric NFM then $P+Q$ is also k -Centrosymmetric NFM.

Theorem:10 If P is k -Centrosymmetric NFM and K is the NFPM, $k=(1/2)$ then KP is also k -centro symmetric NFM.

Proof: An NFM $P \in (NFM)_n$ is said to be k -Centrosymmetric NFM if $P=KP^T K$

Since P^T is also k -Centrosymmetric NFM if $P^T = K P K$

To show that KP is k -Centrosymmetric NFM

It's enough to show, $KP=K(KP)^T K$

$$\begin{aligned} K(KP)^T K &= K(P^T K^T) K \\ &= K P^T \quad (K^T K = I) \\ &= KP \end{aligned}$$

CONCLUSION

We introduced the concept of Centrosymmetric and k - Centrosymmetric NFMs. We also described a method for finding the g -inverse of a Centrosymmetric and k - Centrosymmetric NFM, which emphasis the fundamental principles and theorems of Centrosymmetric and k - Centrosymmetric NFMs, as well as examples.

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15. Reverse Sharp And Left-T Right-T Partial Ordering On Neutrosophic Fuzzy Matrices





Failure Strength Evaluation of Composite Pressure Vessels Made of Fiber- Reinforced Polymers for Aerospace Applications: A Simplified Simulation Analysis Using Finite Element Method

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ABSTRACT

Keeping the economy and safety into consideration, utilizing the maximum strength of a composite pressure vessel is important in the design of aerospace pressure vessels. Experimental analyses are not always amenable due to the high cost and time. Hence analytical assessment of burst pressure of composite pressure vessels is essential. Assessment of first ply failure pressure is simpler, but insufficient since burst pressure is much higher. Determination of burst pressure by progressive failure method is complex and poses a solution convergence problem due to property degradation. The inclusion of damage models helps to get through the convergence problems. But it is complex to include in the solver and a few researchers have negative remarks on it. Without including the damage model, this paper proposes a simplified procedure using finite element analysis software, Ansys. The software helps to find stresses, strains, and displacement in the individual plies. The maximum stress criterion is followed to assess failure. The extent of degradation has been worked out for the failed layers so as to get through the problem of non-convergence at the same time without sacrificing accuracy. Burst pressure estimations have been verified with literature test results, satisfactorily.

Keywords: aerospace, bursting strength/pressure, composite pressure vessel, progressive failure analysis, finite element analysis.





INTRODUCTION

At present, structural efficiency is of prime importance and concern in aerospace applications. Breathing devices, scuba tanks for drivers, oxygen cylinders, and solid rocket motor case are few of the aerospace applications of fiber-reinforced composites [1]. Obviously high specific strength and modulus possessed by fiber-reinforced polymer matrix composite form the basis for being selected as the material for aerospace pressure vessels [2]. Stress rupture needs to be necessarily prevented as it may lead to loss of mission and safety. First-ply failure strength evaluation is primarily needed in the design of composite pressure vessels. Kam et al [3] state that the burst strength of a composite pressure vessel would be much beyond the first ply failure strength. It may be thought as evaluation of first ply failure strength is sufficient but while considering the requirement of lightweight and economy along with safety, bursting strength evaluation is also important [4,5]. Experimental evaluation of first ply failure strength and bursting strength have been fascinating with the development of technology. Kam et al [3] used an acoustic emission set up in which sensors detected the sound produced in the pressure vessel while getting pressurized, till failure. Deformations were measured using strain gauges and data acquisition systems. From the energy – pressure display produced by the system, first-ply failure pressure, as well as ultimate burst pressure, were identified. Shao et al [6] utilized the digital image correlation technique to view the first ply failure initiation and damage propagation until the ultimate bursting. In the light of experimental evidence, many researchers [3,4 and 7] have carried out studies by finite element analysis with reasonable accuracy. Evaluation of first ply failure pressure by programming with classical lamination theory or by the use of finite element analysis packages is in common practice [8,9]. But, burst pressure evaluation is complicated due to the degradation of material properties leading to non-convergence of solutions [4]. There is a need always to reduce the complexities in the analysis such that the designers can adopt the procedure easily. This paper reviews a few of the existing procedures in the numerical investigation for the evaluation of bursting strength of composite pressure vessels. Moreover, a simplified procedure is proposed which is shown to be useful in the prediction of bursting strength of fibre reinforced polymer composite pressure vessels by progressive failure analysis.

A review on progressive failure analysis procedures

Literature including text book [10] talk invariably that one of the following modes would be observed in the failure initiation of composites: fiber breakage, matrix cracking and interface crack propagation. Text book by Kaw [10] outlines the overall procedure and the challenging complexities involved in progressive analysis. It has been declared that the extent of degradation of damaged material properties depends on the philosophy of the user. It prescribes to replace the matrix failed ply with a hypothetical one that has no transverse stiffness, transverse tensile strength and shear strength. It has been mentioned that near zero values avoid singularities in stiffness matrices. Researchers have extensively contributed to this cause either by damage evolution modeling [11-14] or implementing simple procedures on stiffness reduction [15]. Damage models help to improve convergence of solutions [4 and 11]. Chang and Chang [12] have demonstrated a damage model that could provide the following information: damage type, quantification of damage, degradation extent, residual strength and failure load. Damage modeling calculates transformed reduced stiffness matrix which represents the damage on incrementing the load. As damage starts to occur stresses and strains are redistributed.

Different researchers approached the problem of damage modeling with different mathematical functions. There is a presentation of a few post-failure theories in reference [13]. Two of the material degradation models used by them are conceptually shown in figure 1 (a & b). In figure 1(a), Petit-Waddoup's method is depicted in which failed lamina gradually unloads. To implement this theory, a high value of negative tangent modulus is prescribed to the failed lamina. Nahas' theory is presented in figure 1(b) wherein failed lamina gets unloaded exponentially. Damage models have been developed by different authors such as Wu et al [16], Sun et al [17], Nagesh [13] and Martins et al [11]. Ansys gives stress levels only in the universal coordinate system. The stresses need to be transformed into a material coordinate system every time the layers are degraded. Further, if the damage evolution model is to be included, it is more involved to incorporate in the solution routine. Wu et al [16] inferred from their studies that the





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analysis with damage model underestimates the burst pressure by 9.3% as compared to the analysis without damage evolution. Quasi-static progressive failure analysis by explicit finite element analysis yields favorable calculation efficiency without sacrificing accuracy [4].

The Proposed methodology for material degradation

Having given an understanding of the above recommendations, an algorithm is worked out with finite element analysis using Ansys. Writing of Kaw[10] is to be commended for his clear statements regarding progressive failure analysis. By adopting his recommendations, the matrix failed ply shall be replaced with a hypothetical one that has near-zero transverse stiffness, transverse tensile strength, shear modulus, and shear strength. When the fiber of the ply also fails the ply is to be fully discounted by replacing it with the one having near-zero stiffness and strength in all orientations. He has left the assignment of the extent of degradation to the philosophy of the user in case of failure in one of the modes of composites. Recommendations of multiplication factors with relevant properties according to various authors [13,15,17-19] are compiled in table 1. It is to be noted that following equalities have been considered in the analysis: $E_{33}=E_{22}$; $G_{13}=G_{12}$; and $\nu_{13}=\nu_{12}$. Where, E_{11} , E_{22} and E_{33} are young's moduli in the local coordinate system of fiber. Similarly, G_{12} , G_{23} and G_{13} are shear moduli and ν_{12} , ν_{23} and ν_{13} are Poisson's ratios.

A few researchers including [18] recommended a multiplication factor of 10^{-6} for making the properties to have near-zero values. But this leads to non-convergence very easily. If we use 10^{-1} as a multiplication factor as recommended by a few other researchers [13 and 15], the accuracy is highly sacrificed and the expected response of reduced stiffness could not be observed. Hence in order to make the properties have near-zero values, it is proposed to be multiplied with 10^{-3} . When analyzing with the last ply existing, there may be difficulty in achieving the convergence. In such cases, the allowable number of iterations may be set to a higher value. If it is not working, then the multiplication factor may be used as 10^{-2} as a last resort. The proposed multiplication factors in precise are presented in Table 2. A Similar table may be formed for fiber failure mode.

Analysis Procedure

Finite element analysis software Ansys has been used. Quadratic Shell element type SHELL281 has been utilized for modeling the curved surface; SHELL281 is found suitable for the analysis of shell structures of thin and moderately thick sections. The Quarter symmetric segment of the cylinder is modeled by revolving a line about an axis through 90° . Axial length is kept as half the length of the given cylinder in order to maintain symmetry. Mesh convergence study is made with smaller element sizes and the area is finally meshed with an element size of 1 mm in all the analyses. One end of the cylinder is axially constrained, vertical edges are provided with symmetrical constraints and another end of the cylinder is applied with a meridional stress $\frac{pd}{2}$. Where p is applied internal pressure and d is internal diameter. The internal pressure of 1 MPa is always applied and stresses for higher pressures are evaluated by linear interpolation. Figure 2 shows the geometric model created.

Hoop (σ_{xx}), meridional (σ_{yy}) and shear (τ_{xy}) stresses are picked from the Ansys nodal solutions and they are further transformed into stresses along with fiber (σ_{11}), perpendicular (σ_{22}) and shear (τ_{12}) directions using the transformation matrix. The maximum stress criterion is used to predict failure. Failure pressure is computed by dividing the relevant strength by the corresponding stress. Typically, failure pressure is $\frac{Y_T}{\sigma_{22}}$. Where, Y_T is matrix tensile strength. On observing first ply failure, the ply is identified and reduced stiffness and strength values are assigned to it by a property definition separately made available in the program. Now the second ply failure is identified. The position of the failed lamina, failure pressure, and mode will be known. The procedure would be repeated until the last ply is failed. Failure pressure of the last ply is taken as the burst pressure.

It is obvious that for a single agency it is very difficult to fabricate and conduct all instrumented burst tests. Hence, in order to validate the proposed procedure, published results by various researchers have been utilized. In one of such references [3], authors have experimented with cylindrical composite pressure vessels made of graphite/epoxy



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laminates of each lamina thickness of 0.15 mm. Cylinders with 4 ply, 6 ply and 8 ply laminates of different orientations in symmetric arrangements have been tested for first ply failure pressure and burst pressure. All the cylinders have an external diameter of 40 mm and 230 mm long. They have presented analytical results for first ply failure while not for burst pressure. Hence this attempt verifies the burst pressure evaluated by them experimentally. The properties of the lamina as presented by the authors are shown in Table 3. Table 4 shows the properties of lamina made of E-glass/epoxy composites with which Onder et al [7] have conducted experimental studies. All the cylinders have a lamina thickness of 0.4 mm, inner diameter 100 mm and 400 mm long. Moreover, all the cylinders were made of 4 layers both in symmetric and axi-symmetric arrangements.

RESULTS AND DISCUSSIONS

Kam *et al* [3] have tested the composite pressure vessels for first ply failure as well as burst pressure. Their test result displayed from the acoustic emission system for $[54^\circ/-54^\circ/54^\circ]$ Configuration is represented in figure 3. Minor peaks have been excluded in the figure. For this particular configuration, experimental first ply failure pressure is 9.66 MPa and burst pressure is 16.07 MPa. While modeling and analyzing five configurations of the above cylinders, first ply failure pressures obtained have been shown in table 5. Though the result for $[45^\circ/-45^\circ]_s$ has a good agreement, other values are conservative. It was observed that the first ply failure of $[45^\circ/-45^\circ]_s$ configuration occurred in the shear mode as shown in figure 4.

The figure shows how the mode and value of first ply failure pressure are found. The proposed procedure for progressive failure analysis is exercised for the evaluation of the burst pressure of all the five cylinders. In the analysis, it is assumed that once the first ply failure has taken place, the whole ply is failed. But it sustains the load with a reduced stiffness as prescribed in the program. The procedure is repeated layer by layer and the maximum pressure recorded is taken as the burst pressure. Table 5 presents a comparison of analytical results of burst pressure with test values [3]. With regard to the burst pressure prediction, the close agreement is observed. Figure 5 (a) shows the radial displacement of $[90^\circ/0^\circ]_s$ configuration along the axis at first ply failure. Figure 5 (b) shows the radial displacements during the progressive failure of $[90^\circ/0^\circ]_s$ configuration. Figure 6 is a presentation of progressive failure relevant to $[90^\circ/0^\circ/90^\circ/0^\circ]_s$ configuration which has the sequence of failure of ply: 2-4-5-7-1-3-6-8. It is to be noted that the authors [3] analyzed only for first ply failure.

Onder *et al* [7] conducted a burst pressure test as well as analysis in E-glass/epoxy filament wound composite pressure vessels with symmetric and antisymmetric configurations. They analyzed with a program written in Fortran using a derived formulation. Moreover, they have quoted that the finite element method could evaluate only the first ply failure pressure. In this context, the result of the present analysis is of good agreement. One of their efforts was to verify optimum winding angle for filament-wound composite cylindrical pressure vessels to be around 54.75° which is also confirmed in this work. Figure 7 shows a graphical comparison of present analysis with the test results of all the above configurations [7] and in confirmation of an optimum winding angle. Figure 8 shows a good graphical comparison of present analytical results against all the test results [3 and 7]. Most of the results fall within a $\pm 10\%$ variation with the test results. It is to be noted that the authors [7] made a remark about the finite element method that it cannot give close results of burst pressure with the test results. They have shown only the first ply failure pressure and worded as burst pressure.

CONCLUDING REMARKS

There is no unique failure prediction methodology applicable to all composite configurations. Burst pressure estimations are essential in addition to first ply failure prediction in order to ensure safety in lightweight critical applications. Designers need easier approaches in order to assess the failure of composite cylinders designed by





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them. Experimental observations are not always easy. The inclusion of damage evolution models lead to complexity as many modifications are to be included in the solution routine of Ansys. Solution convergence is the problem to be attended to and the same is alleviated without sacrificing accuracy in the present method. The approach is capable of predicting the burst pressure of composite cylindrical pressure vessels satisfactorily.

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Table 1 Recommended Multiplication factors for degradation of properties under matrix failure mode

Reference	E_{11}	E_{22}	G_{12}	G_{23}	ν_{12}	ν_{23}
[10]	1	0.1	1	1	0	1
[11]	1	0.1	1	0.1	1	0.1
[13]	1	0	1	1	0	0
[14]	1	10^{-6}	1	1	1	1
[15]	1	0.1	0.1	1	0.1	1

Table 2 Proposed Multiplication factors for degradation of properties under matrix failure mode

E_{11}	E_{22}	G_{12}	G_{23}	ν_{12}	ν_{23}
1	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}

Table 3 Properties of composites made of graphite/epoxy [3]

Material constant	Value	Strength parameter	Value
E_{11}	88.53 GPa	X_T	1560 MPa
$E_{22} = E_{33}$	6.72 GPa	X_C	1760 MPa
$G_{12} = G_{13}$	4.03 GPa	Y_T	35.75 MPa
G_{23}	1.022 GPa	Y_C	178 MPa
$\nu_{12} = \nu_{13}$	0.28	S	61.72 MPa
ν_{23}	0.4		

Table 4 Properties of composites made of E-glass fibre/epoxy [7]

Material constant	Value	Strength parameter	Value
E_1	36.5 GPa	X_T	1050 MPa
$E_2 = E_3$	15.0 GPa	X_C	938 MPa
$G_{12} = G_{13}$	6.4 GPa	Y_T	43 MPa
G_{23}	1.6 GPa	Y_C	106 MPa
$\nu_{12} = \nu_{13}$	0.24	S	88 MPa
ν_{23}	0.22		





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Table 5 Comparison of first ply failure and burst pressure of graphite/epoxy cylinders

Sl.No..	Lamination arrangement	First ply failure Pressure, MPa		Burst pressure, MPa		
		Test [3]	Present analysis	Test [3]	Present analysis	Relative error, %
1	[54°/-54°] _s	7.18	5.158	14.32	14.942	4.34
2	[45°/-45°] _s	3.47	3.712	10.36	11.975	-15.59
3	[90°/0°] _s	5.68	3.466	11.57	11.869	2.58
4	[54°/-54°/54°] _s	9.66	6.130	16.07	15.810	-1.62
5	[90°/0° /90°/0°] _s	10.41	6.973	20.75	24.220	16.72

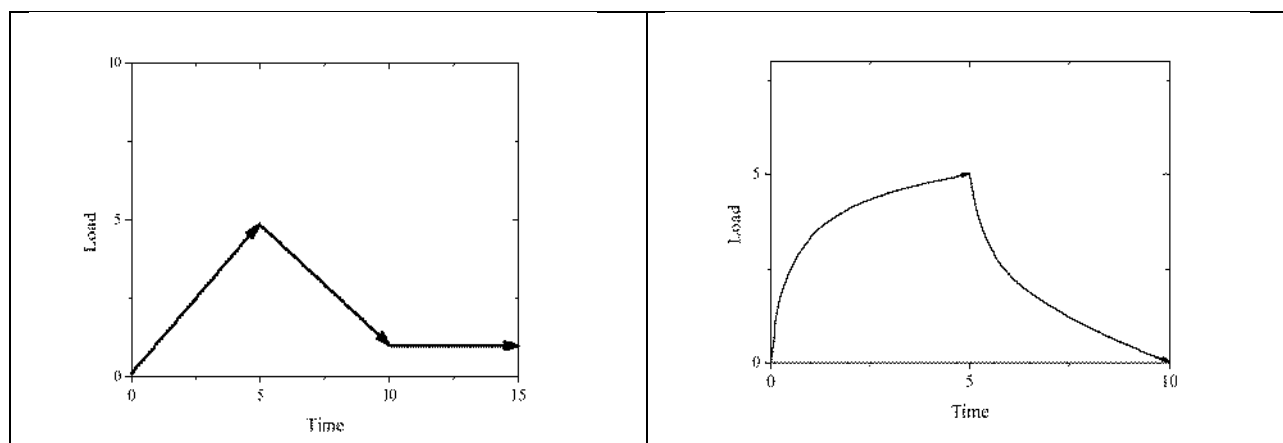


Fig.1 Degradation model of material properties

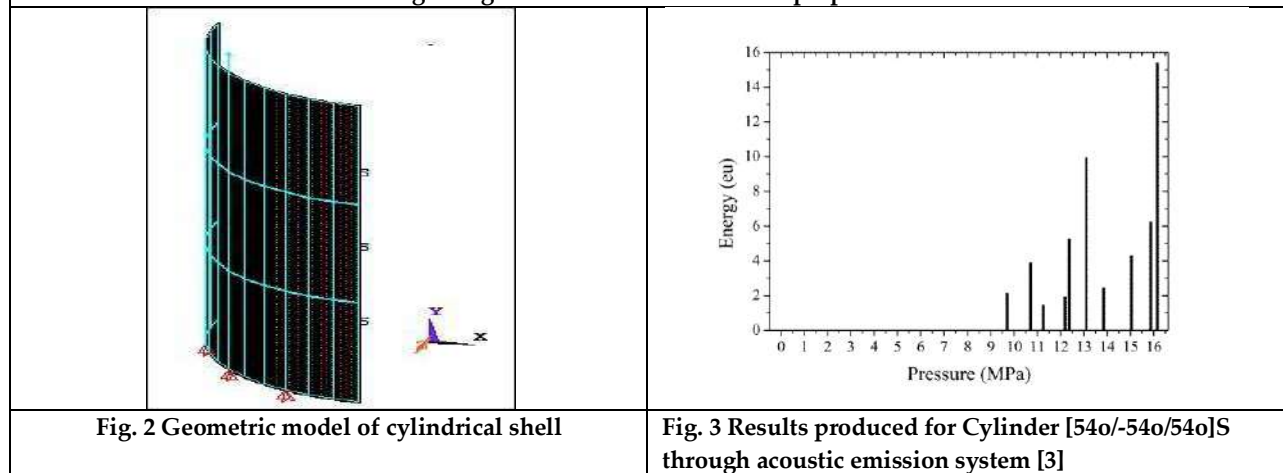


Fig. 2 Geometric model of cylindrical shell

Fig. 3 Results produced for Cylinder [54o/-54o/54o]S through acoustic emission system [3]





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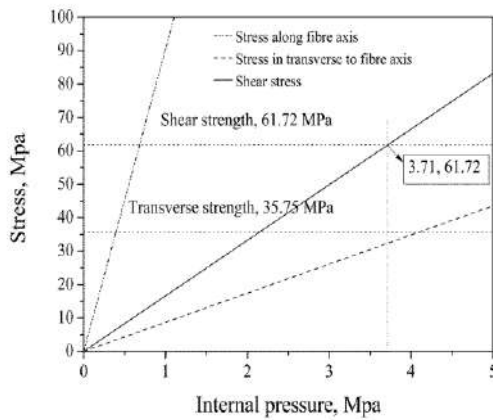


Fig. 4 Shear mode failure of [45o/-45o]S graphite/epoxy cylinder

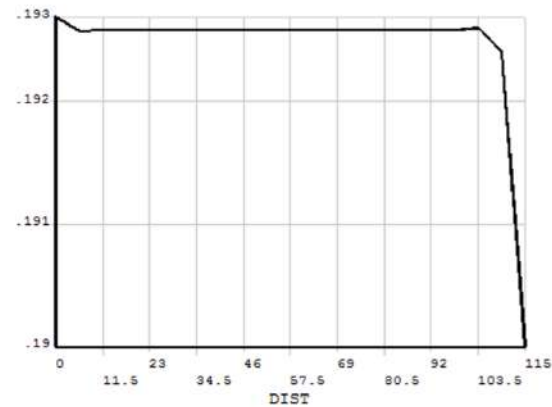
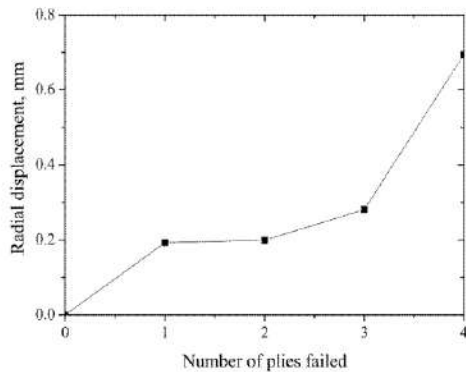
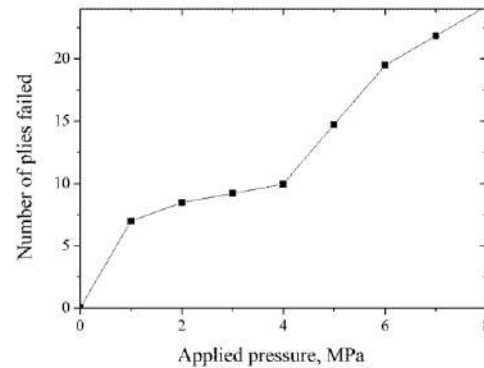
Fig. 5 (a) Radial displacement of graphite/epoxy cylinder [90o/0o]_s configuration along the axis at first ply failure obtained from AnsysFig. 5 (b) Radial displacement of graphite/epoxy cylinder [90o/0o]_s configuration during progressive failure

Fig. 6 Progressive failure of [90o/0o /90o/0o]S graphite epoxy cylinder

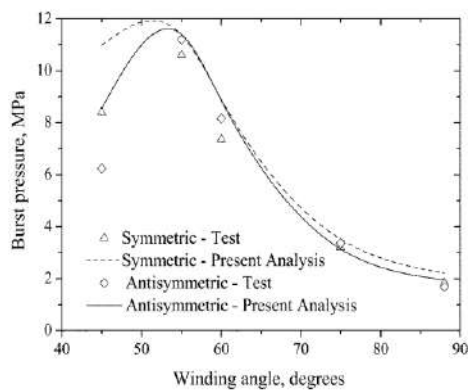


Fig. 7 Comparison of present analysis with test results [7] on E-glass/epoxy composite cylinders.

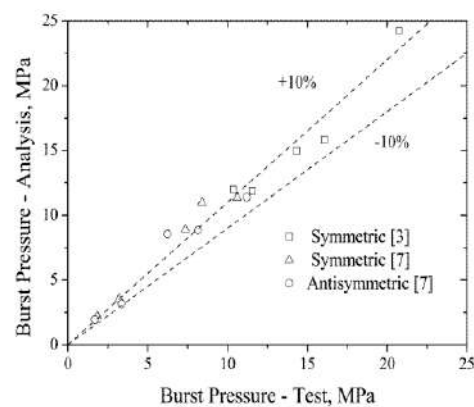


Fig. 8 Comparison of burst pressure analysis with test results





XRD, Hardness, SHG and Dielectric Studies of Potassium Chloride Doped L-Leucinium Oxalate Crystal

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ABSTRACT

Potassium chloride doped L-leucinium oxalate (PCLO) crystals have been grown by solution method. Colourless and transparent crystals of PCLO have been harvested after the period of about 30 days. For comparison purpose, undoped L-leucinium oxalate crystals were also grown. Solubility studies were carried out by gravimetric method. Induction period was measured for the samples at various super saturation values. XRD study indicates that the doped crystal has the triclinic structure like undoped crystal. Mechanical parameters such as hardness, work hardening coefficient, yield strength and stiffness constant of both undoped and potassium chloride doped L-leucinium oxalate were determined. Dielectric parameters like dielectric constant and dielectric loss of the samples have been measured at different frequencies. SHG studies were carried out for both the samples by Kurtz-Perry powder technique and the results are analyzed. LDT value of the sample was also measured.

Keywords: Single crystal; doping; NLO; SHG; XRD; Hardness; dielectrics; Yield strength; LDT





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INTRODUCTION

A crystal is a periodic array of the atoms, ions or molecules. An ideal crystal is constructed by the definite repetition of identical structural unit in space. In a single crystal, the periodicity normally extends throughout the material and it is free from inner grain boundaries [1, 2]. In this work, a single crystal viz. potassium chloride doped L-leucinium oxalate crystal has been grown and studied. It is reported that undoped L-leucinium oxalate crystal is a nonlinear optical (NLO) crystal and on this crystal when high intense light is incident, the re-radiation comes from dipoles whose amplitude does not faithfully reproduce the sinusoidal electric field that generates them. Therefore, the distorted reradiated wave contains different frequencies from that of the original wave [3, 4]. Anbuechziyan et al. reported studies of undoped L-leucinium oxalate grown from aqueous solution. The grown crystals were characterized with single crystal XRD and structure was confirmed. The chemical composition of the sample was determined by carbon, hydrogen and nitrogen analysis. The qualitative analysis on the crystal has been carried by using Fourier Transform Infrared spectral measurements. The presence of hydrogen and carbon in the grown crystal was confirmed by using proton and carbon nuclear magnetic resonance spectral analyses. Optical behavior of the crystal was studied using UV-visible spectroscopy. The thermal stability and decomposition of the crystal were studied by thermogravimetric analysis [5]. L-leucinium oxalate crystal is an organic NLO crystal and it is a complex of amino acid. Amino acid like L-leucine is a bifunctional organic molecule that contains both a carboxylic group as well as an amino group. In solid state amino acid contains protonated amino group and deprotonated carboxylic group. This dipolar exhibits peculiar physical and chemical properties. So the efforts have been made on the amino acid mixed crystal in order to make them suitable for device applications [6, 7]. Growth and characterization of some oxalate-type NLO crystals such as L-alaninium and glycinium oxalate were reported in the literature [8, 9]. Costa Alexandre Saraiva et al. have prepared the crystal of L-leucine oxalate by dissolving L-leucine and oxalic acid in 1:1 molar ratio in deionized water. XRD analysis was carried out. The vibrational behaviors were investigated by Raman spectroscopy in the 298-478K temperature range and spectral range 30-3200 cm^{-1} . At high temperatures, no modification in the Raman spectra was observed, evidencing that the LLO crystal does not present structural phase transition up to melts of the material [10]. In this paper, various studies of potassium chloride doped L-leucinium oxalate (PCLO) crystal are reported and solution method was adapted to grow the crystal of PCLO.

Experimental work

Synthesis, solubility and crystal growth

To synthesize L-leucinium oxalate sample, L-leucine and oxalic acid were taken in 1:1 molar ratio and they are dissolved well in double distilled water. The solution was heated and stirred well for about 2 hours and it is allowed for evaporation to obtain the synthesized sample of L-leucinium oxalate. To obtain the potassium chloride doped L-leucinium oxalate (PCLO), 1 mole% of potassium chloride was added into the aqueous solution of L-leucinium oxalate and by slow evaporation method, the crystals of PCLO were harvested after the period of about 30 days. The grown crystal of PCLO is presented in the figure 1. The solubility of undoped and potassium chloride doped L-leucinium oxalate crystals was carried out by gravimetric method [11]. A known quantity of solute was added into the solvent (water) at constant temperature till it was completely dissolved and saturation level was obtained. By taking the solution in a petri dish and warming it, the solubility was determined. Using this technique, the magnitude of the solubility of the samples was evaluated at various temperatures viz. 30°C, 35°C, 40°C, 45°C and 50°C. The temperature dependence of solubility of the samples is shown in figure 2. From the result, it is observed that the solubility increases with temperature for both the samples. It is also seen that solubility increases when L-leucinium oxalate crystal was doped with potassium chloride. These data can be used for preparing the saturated solution and for carrying out induction period measurements.

Induction period

The time taken between the achievement of super saturation and the appearance of crystal nucleus in a supersaturated solution is known as induction period. Different methods are used for the measurement of induction



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period. Conductivity and turbidity methods are more suitable for materials having low solubility whereas dilatometer and direct vision methods are suitable for materials having moderate solubility and in the present work; the direct vision observation method was used to measure the induction period. For the measurement of induction period, isothermal method [12] was used for the selected super saturation ratios viz. 1.2, 1.24, 1.28, 1.32 and 1.36 at room temperature (30°C). Using the solubility diagram, the samples of undoped and potassium chloride doped L-leucinium oxalate were used to prepare supersaturated aqueous solutions by keeping the super saturation ratio at 1.2 initially in a corning glass beaker, preheated slightly and it was stirred continuously for about 2 hours using a magnetic stirrer to ensure the homogeneous concentration. The nucleation cell was loaded into a constant temperature bath (controlled to an accuracy of 0.01°C) and illuminated using a powerful lamp to observe the formation of nucleus. The time interval in which the first speck or sparkling particle of nucleation occurred in the solution is noted and this is the induction period for formation of nuclei for the super saturation ratio 1.2. Similarly, induction period measurements were performed at the other super saturation ratio. The variation of induction period with super saturation ratio for samples is provided in the figure 3 and from the results, it is noticed that the induction period decreases with the super saturation ratio. The induction period is observed to be increasing when potassium chloride was added into L-leucinium oxalate.

RESULTS AND DISCUSSION

Single crystal XRD studies

In X-ray diffraction (XRD) technique, a monochromatic X-ray beam be incident at Bragg angle (θ) on the set of lattice planes with interplanar spacing (d) in a particular crystalline sample so that the Bragg's diffraction condition $2d \sin \theta = n\lambda$ for the particular lattice planes is satisfied. Here n is the order diffraction and λ is the wavelength of X-rays. There are two X-ray diffraction methods namely powder XRD and single crystal XRD methods. In this work, single crystal XRD method was adopted because the grown sample of PCLO is a single crystal. The unit cell constants for potassium chloride doped L-leucinium oxalate crystal were collected by using single crystal X-ray diffractometer (Bruker-Nonius MACH3/CAD4). It is observed that the grown crystal of PCLO of this work belongs to triclinic crystal system with the unit cell parameters $a = 5.653(2) \text{ \AA}$, $b = 9.785(3) \text{ \AA}$, $c = 9.883(2) \text{ \AA}$ and $\alpha = 88.23(1)^\circ$, $\beta = 98.42(4)^\circ$ and $\gamma = 101.74(2)^\circ$. The crystallographic data of undoped L-leucinium oxalate crystal have been already reported [5] and from the comparison of the data, it is confirmed that crystal structure is not changed when potassium chloride was added as the dopant into L-leucinium oxalate crystal.

Hardness, work hardening coefficient and stiffness constant

Mechanical properties like hardness, stiffness constant and yield strength of the samples have been found by carrying out microhardness studies. Hardness testing has been widely used to study the strength and deformation in materials. Hardness is defined as the ratio of the load applied to the surface area of the indentation. Hardness of the material depends on different parameters such as lattice energy, Debye temperature, heat of formation and interatomic spacing. Crystals, free from cracks, with flat and smooth surfaces were chosen for the static indentation tests. The crystal was mounted properly on the base of the microscope. Now, the selected faces were indented gently by loads varying from 20 to 60 g for a period of 10 s using Vickers diamond indenter attached to an incident ray research microscope. The length of the two diagonals of diamond indenter was measured by a calibrated micrometer attached to the eyepiece of the microscope after unloading and the average was found out. For a particular load, at least three well defined indentations were considered and the average value (d) was selected. The Vickers hardness (H_v) numbers at different loads were calculated using the following relation

$$H_v = 1.8544 P / d^2$$

where, 'P' is the applied load in kilogram and 'd' is the average diagonal length of the indentation marks in millimeter. The variation of hardness number with applied load for the samples is shown in the figure 4. The grown crystal exhibits the reverse indentation size effect (RISE), in which the hardness value increases with the increasing load upto 40 g and then it decreases [13-15]. When potassium chloride was added as the dopant into L-leucinium oxalate crystal, it seems that hardness increases and this leads to conclusion that bond strength increases when potassium





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chloride was used as the dopant. The plots of average value of diagonal indentation (d) versus the applied load (P) are presented in the figure 5 and using these values the Meyer's plots are drawn (Figs.6 (a) and (b)). Meyer's law given by

$$P = a d^n$$

where ' a ' is the material constant, ' n ' is the Meyer's index or work hardening coefficient [16]. This law is used to find the work hardening coefficient (n). The plots of $\log(P)$ against $\log(d)$ which gives a straight line and the slope of the line gives the value of n . The values of work hardening coefficient (n) for undoped and potassium chloride doped L-leucinium oxalate crystals are 1.664 and 1.758 respectively. Yield strength of the material can be found out using the following relation

$$\text{Yield strength } (\sigma_y) = (H_v/3)$$

where σ_y is the yield strength and H_v is the hardness of the material. Yield strength is the maximum stress that can be developed in a material without causing plastic deformation. The elastic stiffness constant (C_{11}) for different loads was calculated using Wooster's empirical formula

$$C_{11} = H_v/4$$

It gives an idea about the measure of resistance of plastic to bending and tightness of bonding between neighboring atoms [17-18]. The plots of yield strength and stiffness constant with applied load for the samples are presented in the figures 7 and 8. The results indicate that behaviour of yield strength and stiffness constant of the samples is found to almost the same as the hardness of the samples. It is observed that yield strength and stiffness constant increase with increase of load upto 40 g and then these values decrease.

Dielectric constant and dielectric loss

In dielectric materials, the most commonly measured small signal electrical property is the dielectric constant. The dielectric constant in polar materials is rarely a constant, but varies with the applied field, stress, temperature and other parameters. When a dielectric is placed in an external electric field, electrons of the ions are displaced slightly with respect to the nuclei and thereby induced dipole moments result and it causes the electronic polarization. When atoms of different types form molecules, they will normally not share their electrons symmetrically and the electron clouds will be displaced eccentrically towards the stronger binding ions. Thus the ions acquire charges of opposite polarity and an external field acting on these net charges will tend to change the equilibrium positions of the ions themselves. By this displacement of charged ions or groups of ions with respect to each other, a second type of polarization viz. ionic polarization of the dielectric is created. The asymmetric charge distribution between the unlike partners of molecule gives rise, in addition, to permanent dipole moments which exists even in the absence of an external electric field. Such moments experience a torque in an applied field that tends to orient them in the direction of the field. Consequently, an orientational (dipolar) polarization can arise.

These three mechanisms of polarization are due to charges locally bound in atoms, molecules or in the structure of solids. Additionally to all these, there usually exist charge carriers that can migrate for some distance through the dielectric. When such carriers are impeded in their motion, space charges and macroscopic field distribution result. Such a distortion appears as an increase in the capacitance of the sample. Thus a fourth type of polarization called the space charge polarization comes into play. The total polarization is a sum of four polarizations if they act in a dielectric independently. The dielectric constant (ϵ_r) and loss factor ($\tan \delta$) were measured using an LCR meter for undoped and potassium chloride doped L-leucinium oxalate (PCLO) crystals. Fig.9 and 10 present the variations of dielectric constant and dielectric loss factor with frequency at room temperature. From the results, it is observed that both the dielectric parameters decrease as frequency decreases for samples. The high values of ϵ_r at low frequencies may be attributed to dominance of space charge polarization. It is observed that the crystals of this work have low dielectric constant and low dielectric loss at higher frequencies and hence suitable for electro-optic applications. In accordance with Miller's rule, the lower value of dielectric constant at higher frequencies is a suitable parameter for the enhancement of SHG coefficient. The results indicate that the dielectric constant and loss factor increase when L-leucinium oxalate crystal is doped with potassium chloride [19-22].



**Rajesh Kannan et al.,****NLO activity**

Nonlinear optical organic materials will be the key elements for future photonic technologies. Photonic technologies are analogous to the field of electronics. Photonics technologies are based on the fact that photons are capable of processing information with the speed of light. In electronic devices, electrons are the key elements performing multifunction, whereas in photonic devices photons will perform the same functions of a much faster speed and in a cleaner and easier way. An important development in a non-centrosymmetric crystal when researchers reported the second harmonic generation (SHG) and it is called as the frequency doubling. Powder second harmonic generation test offers the possibility of assessing the nonlinearity of the materials. The second harmonic generation behavior of the powdered material was tested using the Kurtz and Perry method [23]. Calibrated polycrystalline samples were illuminated by nanosecond pulses at the fundamental wavelength $\lambda_o=1064$ nm, delivered by an Nd:YAG laser with a pulse width of 10 nanoseconds and a repetition rate of 10 Hz. In the case of phase matchable crystals, with the powder SHG efficiency being an increasing function of the particle size, a large calibration (150-200 μm) was chosen for the powder under test and the phase matchable material taken as a reference sample (KDP). The emission of green laser light from the samples confirms that these samples are second order NLO materials. SHG efficiency of the undoped L-leucinium oxalate crystal is found to be 0.65 times that of the standard KDP crystal. The SHG efficiency of potassium chloride doped L-leucinium oxalate (PCLO) crystal is observed to be 0.83 times that of KDP. Thus, potassium chloride doped L-leucinium oxalate crystal is the better candidate for NLO applications than the undoped L-leucinium oxalate crystal.

LDT measurement

Laser damage threshold (LDT) values of the samples have been measured using a Q-switched Nd: YAG laser with a pulse duration of 10 nano seconds. The grown crystals of undoped and potassium chloride doped L-leucinium oxalate crystals are polished and are subjected to LDT studies. LDT value is defined as the maximum power density required to create a damage on the surface of the crystal and it depends on the physical and chemical defects, specific heat, thermal conductivity and optical absorption etc. The LDT value of the crystal was calculated using the expression, power density (P) = $E/\tau\pi r^2$, where E is the energy (mJ), τ is the pulse width, r is the radius of the laser beam spot. The calculated values of LDT are 1.412 GW/cm² and 1.760 GW/cm² respectively for undoped and potassium chloride doped L-leucinium oxalate crystals. The LDT value of KDP crystal is 0.2 GW/cm² [24]. Thus, LDT values of the grown crystals are more than that of KDP crystal. Hence, the grown crystals are the better candidates for NLO and laser applications.

CONCLUSION

A comparative study has been carried out for both undoped and potassium chloride doped L-leucinium oxalate (PCLO) crystals and the samples have been grown in the form of single crystals by solution method with slow evaporation technique. Both the samples have positive temperature coefficient of solubility and solubility of PCLO crystal is observed to be more than that undoped L-leucinium oxalate crystal. Induction period of the samples have been measured and it decreases as the supersaturation ratio increases. Both the samples crystallize in triclinic structure. Hardness, yield strength and stiffness constant of PCLO crystal are found to be higher than those of undoped sample. Dielectric constant and dielectric loss of both the samples are observed to be decreasing as the frequency increases. The value of relative SHG efficiency of PCLO crystal is 0.83 times that of KDP sample. LDT value of potassium chloride doped L-leucinium oxalate crystal is observed to be more than that of undoped L-leucinium oxalate crystal.

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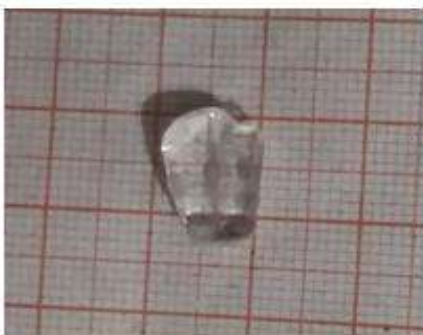


Fig.1. The grown crystal of PCLO

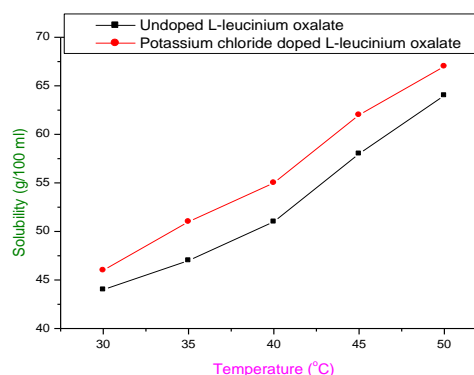


Fig.2: Solubility curves for undoped L-leucinium oxalate and potassiumchloride doped L-leucinium oxalate (PCLO) crystals



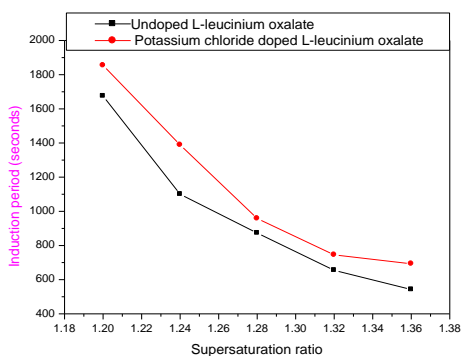


Fig.3: Variation of induction period with supersaturation ratio for unoped L-leucinium oxalate and potassium chloride doped L-leucinium oxalate (PCLO) samples

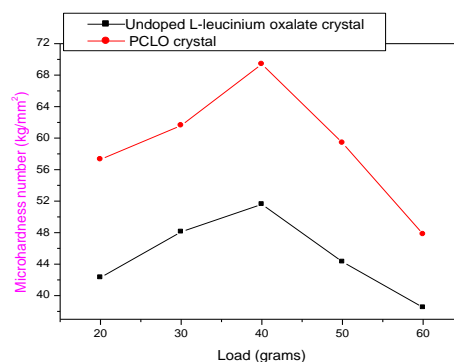


Fig.4. Variation of microhardness with load for unoped and potassium chloride doped L-leucinium oxalate crystals

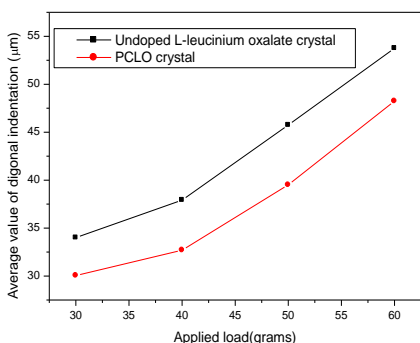


Fig.5. Plots of average value of diagonal indentation (d) versus the applied load (P) for both the samples

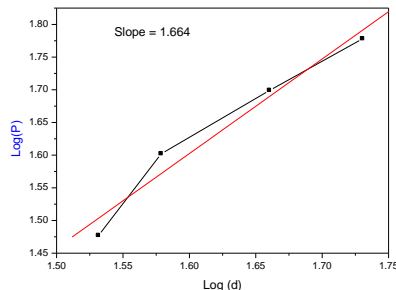


Fig.6 (a). Plot of log (P) versus log (d) for unoped L-leucinium oxalate crystal

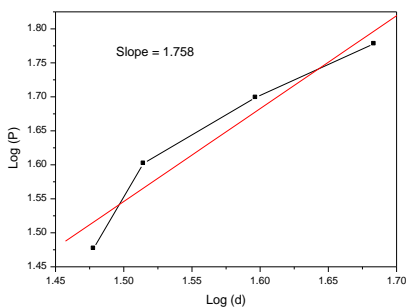


Fig.6 (b). Plot of log (P) versus log (d) for potassium chloride doped L-leucinium oxalate crystal

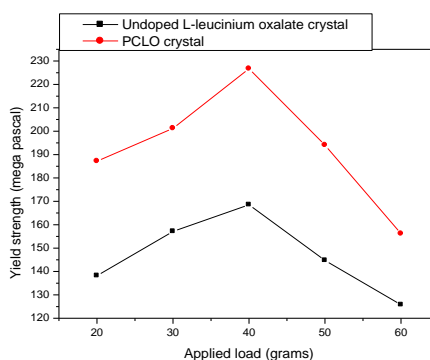
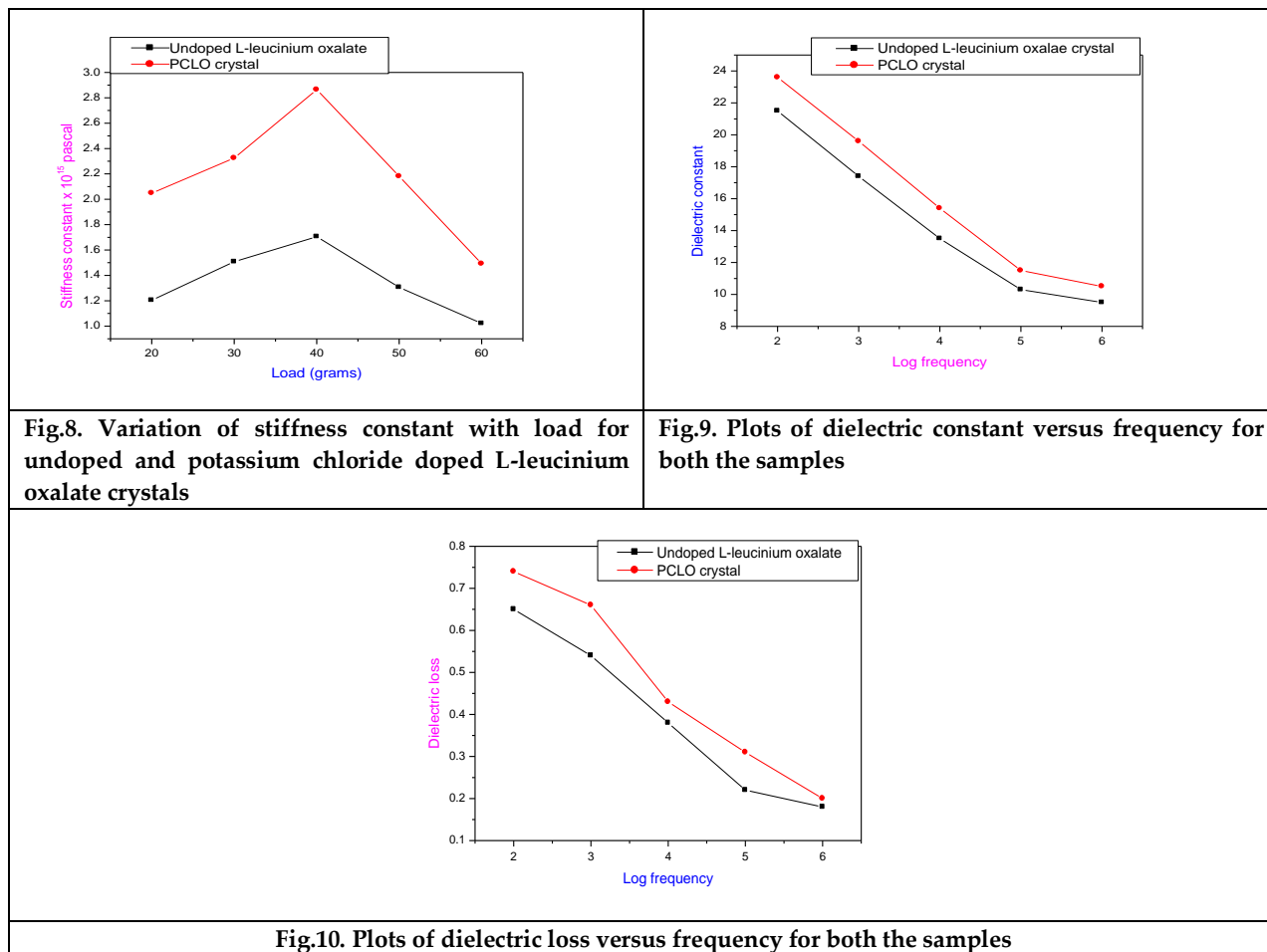


Fig.7. Variation of yield strength with load for unoped and potassium chloride doped L-leucinium oxalate crystals



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A Study of Learning Style and Academic Performance of PG Students of Central University of Jammu

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ABSTRACT

The present study was an attempt to investigate the study of learning style and academic performance of PG students of Central University of Jammu. The data was collected randomly from the sample of 90 students, each 30 students from the department of Science, Social Science and Educational Studies. The self constructed opinionnaire tool employed for data collection of the study. Frequency and Mean used for data analysis of the study. The results revealed that there were significant differences in learning style of students with respect to their discipline and Visual learning style was the most prominent learning style on the basis of academic performance of students with respect to their discipline of the study.

Keywords: Learning style, Academic performance, Discipline, students.

INTRODUCTION

Every human being is rational animal because he/she has got the power of reasoning. This power of reasoning enables him/her to learn things quickly. Differences among people are reflected not only in how they think, communicate, and relate etc but also in the way each one learns. Learning may be properly defined as a relatively permanent change in behaviour(excluding the influence of growth , maturity or lesion).Every student learns in different way that best suit his/her learning needs and they use different styles for learning which enables them to be successful at their academic career. The notion of style refers to a person who preferred different way according to their abilities. This help to achieve the success in life. It is now confirmed that learning differences are caused by



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intelligence differences as well as other factors like personality traits, task difficulty, and learning styles. The traditional belief that learning differences are the result of intelligence differences and different cognitive abilities has changed. Everyone has a different preferred method of learning. It's a frequent misconception that learning styles have more to do with "how" than "what" children choose to learn, even though they play a significant role in determining students' attitudes and academic success. A person's tendency towards particular learning methodologies is referred to as their learning style. Kolb defined learning style as "the way we prefer to absorb and incorporate new information. Students have different styles of learning. Teachers identify different learning styles of their students and adjust his/her teaching method according to each student's needs.

Learning Style theory starts by Carl Jung (1927) who noted major differences in the way people perceived sensation versus intuition, the way they made decisions logical thinking versus imaginative feelings and how active or reflective they were while interacting extroversion versus introversion. Knowledge of one's learning styles can be used to increase self awareness about their strengths and weakness as learners. Every individual have their own learning style. Learning style encompasses motivation, on task persistence versus the need for multiple assignments simultaneously, the kind and amount of structure required and conformity versus mis conformity. Merrill (2000) argues that most of students are unaware of their learning styles. All the advantages claimed for metacognition can be gained by encouraging learner to become knowledgeable about their own learning styles and that of others (Coffield, 2004). Once students have brought this knowledge into their level of awareness, they are better suited to choose learning strategies that match their learning styles. This initiative student ownership of the educational process. One of the most significant issues in learning to learn is an individual's taking the responsibility for his/her own learning the individuals should know what their own learning styles are and what characteristics this style has and they should thereby behave according to this style. In this way, the individual can acquire the constantly changing and increasing amount of information without need for the assistance of others. When the learner takes the responsibility of his/her own learning, s/he attributes meaning to the process of learning.

TYPES OF LEARNING STYLE

Learning is an extremely important and personal experience for people of all ages. Years ago, there was an assumption that everyone learned new material the same way. But overtime, research discovered there are a number of different types of learning styles and different ways that humans retain and process information.

Visual learning style

These people prefer to use pictures, images, diagrams, colors, and mind maps. How to identify the learners who learn by visual learning style?

1. Sit in front.
2. Watch instructors' gestures constantly.
3. Watch videos.
4. Fast talker learner.
5. Use colored highlighters to color code texts and notes.
6. Use maps, charts, diagrams, PowerPoint and lists.
7. Watch audiovisuals.
8. Take photographs.
9. Use flashcards.
10. Use notebooks.
11. Watch instructor's mouth and face.
12. Use visual chains or mnemonics.
13. See parts of words.

Auditory learning style

People who prefer using sound (obviously), rhythms, music, recordings, clever rhymes, and so on. How to identify the learners who learn by auditory learning style?



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1. Like to talk and talk to self.
2. Lose concentration easily.
3. Prefer spoken directions into written direction.
4. Prefer lecture and discussion method.
5. Prefer verbal praise from teacher.
6. Record lecture for repeated listening.
7. Use rhymes to help memories.
8. Read loudly and listen carefully.
9. Listen recorded material while go to study.
10. With new processes, Talk about what to do, how to do it and why it's done that way.

Verbal learning style

The verbal learner is someone who prefers using words, both in speech and in writing to assist in their learning. They make the most of word based techniques, scripting, and reading content aloud. How to identify the learners who learn by Verbal learning style?

1. Use mnemonics.
2. Work in group.
3. Sharing more ideas to other both in written as well as verbal
4. Difficulty in chart, map reading.
5. Ability to quickly and accurately respond.
6. Careers in politics, writing and speaking.
7. Feel enjoy in writing and speaking.

Logical learning style

The people who prefer using logic, reasoning, and “systems” to explain or understand concepts. They aim to understand the reasons behind the learning, and have a good ability to understand the bigger picture. How to identify the learners who learn by logical learning style?

1. Analysis of cause & effect relationship.
2. Give logical, clearest explanations.
3. Provide information through bullet point, to do list.
4. Give students a chance to think strategically.
5. Strong visual analysis, problem solving skill.
6. Most of time spend in study of Maths & Science technology.
7. Find careers engineers scientists mathematicians and detectives.

Social learning style

These people are the ones who enjoy learning in groups or with other people, and aim to work with others as much as possible. How to identify the learners who learn by social learning style?

1. Share stories & compare own ideas with other.
2. Present opportunities for student to work & learn from groups of other.
3. Careers in teaching scales and counselling.
4. Develop small study group & peers to peer tutoring session.
5. They enjoy organizing events, people & groups.
6. Understand other people & resolving conflicts.
7. Difficult doing in work alone.
8. Their strength lies with communicating.
9. They enjoy activities like speech, drama debate.
10. They enjoy taking leadership roles & participating in group.
11. Prefer learning through interpersonal communication & interaction.
12. Learner love to interact with peers & friends.



**Sneh Devi and Kiran****Solitary learning style**

The solitary learner prefers to learn alone and through self-study. How to identify the learners who learn by solitary learning style?

1. More private, Introspective.
2. Motivated by internal force.
3. Spend more of time alone.
4. Find ways to allow these students to study quietly and free of distractions.
5. Work independently.
6. Careers in data analysis research, security.

Kinesthetic learning style

These are the “learn by doing” people that use their body to assist in their learning. Drawing diagrams, using physical objects or role playing are all Strategies of the Physical learner. How to identify the learner who learns by kinesthetic learning style?

1. Study in short block of time.
2. Walk or move while reviewing your notes.
3. Scientific in nature.
4. Doing.
5. Participating.
6. Experiences.
7. Field trips.
8. Models.
9. Movement.
10. Visit a location.
11. Work in group.
12. Make a game.
13. Role play in class.
14. Comfortable activities.
15. Hands on problem solving.
16. Multiple choices.
17. Long written tests.
18. Don't like long lectures.
19. Do creative work.

JUSTIFICATION OF THE STUDY

As the investigator start his writing with great thought of Franklin D.Roosevelt “we cannot always build the future for our youth, but we can build our youth for the future”, it indicates any study which may directly or indirectly concerned with the problems of individual and able to contribute something for the development of their future is worthy. It is believed that learning style plays an important role to permanent change in behaviour of individual and helps to achieve the success in life. Learning styles are not really concerned with “what” learners learn, but rather “how” they prefer to learn and it is important factor for students’ academic achievements and attitudes. While every individual is unique and learning styles differ from one individual to another. Problems of learning are becoming serious and increase day by day with increasing rate of competition. It brings challenges in every parts of life. Damavandi et al.(2011) in their study found that there was a statistically significant difference in the academic achievement of the Iranian students that correspond to the four learning styles i.e. VARK. Beyza(2012) in his study determined there was no effect of some personal characteristics such as age, gender of the secondary school students on their learning styles. Alade and Ogbo(2014) founded in their study that there was significant relationship between learning style preferences of students and their performance in both public and private schools and visual learning style was the prominent preference among students in both school. Karalliyadda (2017) investigated that there was no significant relationship between learning styles and academic performance and he also founded that students of



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agriculture more interested in kinesthetic learning style. There are many research studies conducted on learning style with relation to the gender, academic achievement, academic motivation and other dimension but very few studies conducted on students' learning style towards their academic performance of different discipline (Science, social sciences and Language) but few studies carried on seven different learning styles in Jammu and Kashmir. This study is helpful in bringing a positive change in behaviour of students, bring new innovations in the classroom and also helpful for teachers to improve the academic performance of the students according to their learning style. Hence the studies of students' learning style towards their academic performance of different discipline (Science, social sciences and language) gain its own importance.

RESEARCH QUESTIONS OF THE STUDY

1. Is there any relation between learning style and academic excellence?
2. Whether the nature of discipline compliments nature of learning style for Academic excellence?

STATEMENT OF THE PROBLEM

In the light of above discussion on different Learning style and other related dimensions, the investigator undertook the problem which is stated as under: A STUDY OF LEARNING STYLE AND ACADEMIC PERFORMANCE OF PG STUDENTS OF CENTRAL UNIVERSITY OF JAMMU

OPERATIONAL DEFINITION OF KEY TERMS USED

Student: In this study, Student refers to one who is enrolled or attends classes in the central university of Jammu.

Learning Style: Learning style refers to the way or pattern of student who learn from the style of auditory, visual, logical, kinesthetic, solitary, verbal and social.

Academic performance

Academic performance is the extent to which a student has achieved their short or long-term educational goals.

OBJECTIVES OF THE STUDY

1. To identify the differences in learning style of students with respect to their discipline of the study.
2. To find out the prominent learning style on the basis of academic performance of students with respect to their discipline of the study.
3. To suggest measures for enhancement of academic performance of the students belong to different discipline on the basis of finding of the research.

DELIMITATIONS OF THE STUDY

1. The present study has been delimited to Samba district only.
2. The present study has been delimited to Students of Central University of Jammu only.

RESEARCH METHOD

Descriptive exploratory research method was adopted for the present study.

POPULATION OF THE STUDY

In the present study, the population constituted of all the students who were in 3rd semester of their Post graduate degrees in Science, Social Sciences and Languages in Central University of Jammu.

SAMPLING**SAMPLING TECHNIQUES**

The investigator used random sampling for selection of the sample in the present study.





SAMPLING PROCEDURES

Total three Departments, one each from the three Departments providing P.G. degree in Science subjects, three departments providing P.G. degree in Social Sciences subjects and two department providing P.G. degree in Languages were selected randomly through lottery method for data collection. The following table provides detailed description of the sample for the present study. Number of students constituting the final sample in the above table 2 represents the students who were present in their classes when the investigator went for data collection in the respective Departments.

TOOL AND TECHNIQUES FOR DATA COLLECTION

For each and every type of research the investigator needs certain instruments. The instruments thus employed are called tools. The selection of suitable tools is of vital importance for successful research. Different tools are suitable for collecting various kinds of information for various purposes. Selection of tool for data collection depends upon the nature of the problem undertaken. For the present study, the tool was self constructed by the investigator on the advice and consultation of Supervisor.

DEVELOPMENT OF TOOL

The description of self constructed opinionnaire tool is as under-

Steps taken for the construction of Opinionnaire

The following steps were taken by the investigator during the construction of a opinionnaire:

1. Decide what information is required
2. Make a rough listing of the statements
3. Refine the statements phrasing
4. Develop the response format
5. Put the statements into an appropriate sequence
6. Finalise the layout of the opinionnaire
7. Pre-test and revise

Validation of Tool

After the tool was constructed, the investigator established the validity of the tool. For this, the draft of tool was circulated amongst the peers, scholars, subject experts and language experts for acquiring their suggestions. They suggested number of changes in the tool and on the basis of their suggestions some items were modified, some items are deleted and some new items were incorporated in the tool.

ADMINISTRATION OF THE TOOL

The investigator visited the selected departments personally for the collection of data, pertaining to her problem. The investigator approached the teachers and explained to them the nature and purpose of the investigation. They were kind enough to permit the investigator. The investigator also assured the students that their responses would be kept confidential and utilised only for research purpose, so they should try to be an honest and sincere in responding to each question. After giving the proper instruction and guidelines to every student. The investigator distributed the opinionnaire to the students and explained to each items. At the end when the students filled their responses in the opinionnaire then the investigator taken back the opinionnaire from the students. In this way, the investigator collected the data from the students required for her research work.

SCORING OF THE TOOL

The Opinionnaire of learning style consists of 21 statements which is based on seven different learning styles and each items followed by 5 possible answers. For statements the scoring is 5, 4, 3, 2, 1, for strongly agree, agree, neutral, disagree and strongly disagree respectively. It means that maximum scoring is awarded to expressing the usage of type of learning style.



**Sneh Devi and Kiran****DATA ANALYSIS TECHNIQUES**

The present investigation employed following techniques:

- Frequency
- Mean

Table 3 exhibited the learning style-wise categorization of academic performance scores of the thirty (30) PG students of Science discipline. As emerged from the analysis of the data obtained, logical learning style had been emerged to be the prominent learning style among the students of science discipline as out of thirty (30) students eight (8) students belonged to this style of learning. The mean value (381.1) of the academic performance scores for the logical learning style also closely approximate the overall mean (404) for science discipline. Thus, not only the number of the students who fell under the logical learning style was high, the students belonging to this learning style are also excelling academically as indicated by the mean score for this category. Besides logical learning style; visual and verbal learning style were also found to be close to logical learning style on grounds of number of students falling under these learning styles six in each stylistic category and the mean score of academic performance of the students under these two categories. The mean score for visual learning style is 395 which is even higher than the mean score of logical learning style and is closer to the overall mean score (404) of academic performance. The data obtained thus, clearly shows that the student who pursue science discipline mainly prominently belong to three kinds of learning styles i.e. logical learning style, visual learning style and verbal learning style. Other kinds of learning style i.e. kinesthetic, auditory, solitary and social learning were found to be less prominent amongst the students pursuing Science subjects at PG level. The reason may be Science as subject/discipline demands students' indulgence in having hands on experiences through experimentation, use of demonstration, graph, chart and creative projects etc. for learning. Moreover, it's the nature of Science which seeks logic and reason to be the foundation of better learning. Science students have ability to solve the problem and find out the reason, keen observation analysis of cause and effects relationships.

Table 4 exhibited the learning style-wise categorization of academic performance scores of the thirty (30) PG students of Social Science discipline. As evident from the table, visual learning style had been emerged to be the prominent learning style among the students of Social Science discipline as out of thirty (30) students twelve (12) students belonged to this style of learning. The mean value (420) of the academic performance scores for the visual learning style also higher than the overall mean (409.13) for the Social Science discipline. Thus, not only the number of the students who fell under the visual learning style was high, the students belonging to this learning style are also excelling academically as indicated by the mean score for this category. The highest scorer of the discipline also fell in the category of visual learning style. Beside visual learning style; logical and social learning style were also found to be approximately close to visual learning style whereas the seven students falling under logical learning style and five students falling under social stylistic category. The mean score for logical learning style 402.8 and social learning style (395.6) which is even approximately nearest to the mean score of visual learning style and is closer to the overall mean score (409.13) of academic performance. Thus the data obtained clearly shows that the student who pursue Social Science discipline prominently belong to three kinds of learning styles i.e. visual learning style, logical learning style and social learning style. Other kinds of learning style i.e. solitary, verbal and auditory learning were found to be less prominent amongst the students pursuing Social Science subjects at PG level. In addition to this, no students were found to be adapted kinesthetic style of learning. The reason may be Social Science as subject/discipline which helps to aware the human relationships with socio-cultural environment such as economical behaviour, common cultural behaviour, traditions, political behaviour and religious faith and also help to aware the students how to develop the society as well as the world. The students of Social sciences have ability to solve problem in the real world as creative thinking practice to see things around in various perspective in sequential way.

Table 5 revealed that the learning style-wise categorization of academic performance scores of the thirty (30) PG students of Languages as subject/discipline. On analyzing the data obtained from the students, visual learning style had been emerged to be the prominent learning style among the students of Languages as out of thirty (30) students; nine (9) students belonged to this style of learning. The mean value (306.1) of the academic performance scores for the visual learning style also closely approximate the overall mean (307.46) for discipline of Languages. Thus, not



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only the number of the students who fell under the visual learning style was high, the students belonging to this learning style are also excelling academically as indicated by the mean score for this category. From this table, Logical learning style also found to be close the visual learning style because eight students falling under this style and its mean score(304.7) of academic performance of the students is nearest to the mean score of visual learning style. While the mean score for verbal learning style (317) which is highest to the mean score of visual learning style and is uppermost to the overall mean score (307.46) of academic performance of students of Languages. In addition to this, no students were found to be adapted kinesthetic style of learning. Thus, the data obtained clearly illustrates that the student who persuade the discipline of Languages prominently belong to three kinds of learning styles i.e. visual learning style, logical learning style and verbal learning style. Even as the other kinds of learning style i.e. solitary, social and auditory learning were found to be less prominent amongst the students pursuing the discipline of languages at PG level. The reason may be language as subject/discipline emphasis on reading and writing, lectures, Keen observation, creative thinking (concept formation, creative hypothesis formulation, strengthened capacity to identify, understand and solve problem), good communication skills, grasp the beauty of nature and imaginative thinking, doing work in systematic way.

Table 6 demonstrated the learning style-wise categorization of academic performance scores of the ninety (90) PG students of Discipline of Science, Social Sciences and Languages. As emerged from the analysis of the data obtained, comparison of all seven learning styles of three discipline the overall mean value score of Social Sciences is 409.13 and overall mean value score of Science is 404 which is utmost from total mean value score 357.03. The calculated mean value score of language is 307.46 which is approximately least than total mean value score 357.03. The obtained data clearly shows that the students who persuade the discipline of Science and Languages prominently belong to three kinds of learning styles i.e. visual learning style, logical learning style and verbal learning style. Besides these disciplines, the students of Social Sciences discipline prefer to learn by visual learning style, logical learning style and social learning style. The number of students fallen under visual learning style (27), logical learning style (23), (15) students came under verbal learning style and social learning style prefer (9) students as compare to the other style of learning. As per the table, the least number of students were found to be adapted kinesthetic style of learning in overall the disciplines. This table shows that Visual learning style is the most prominent learning style across over all the disciplines. The findings of the study was in agreement with the study of Alade and Ogbo (2014) whereas the present study disagreement with Damavandi et al. (2011), Beyza (2012), Karalliyadda (2017) and Alkooheji and Hattami(2018).

MAIN FINDINGS OF THE STUDY

The main finding revealed that there is the difference in learning style of students with respect to their discipline of the study. The finding revealed that Visual learning style is the most prominent learning style on the basis of academic performance of students with respect to their discipline of the study.

EDUCATIONAL IMPLICATIONS OF THE STUDY

1. The finding of the study revealed that there is a significant difference in learning style of students with respect to their discipline of the study. The study reveals that students of all disciplines prefer to learn by different styles of learning. So, the teacher should engage students in inquiry by providing opportunities to experiment, analyze information critically, make assumptions and solve problems both individually and in groups.
2. The finding of the study revealed that visual learning style is the most prominent learning style. The teachers must address each learning style in their teaching to increase positive attitude of the students toward the teaching and learning process.
3. Teacher should give the task of assignment on the basis of different teaching learning styles like video-lecture, problem-solving, role playing, drama, skit, poetry.
4. Teachers must address to learning style of students for fostering the individual differences.
5. Being aware of their learning style, the students may contribute to their academic success by promoting self-awareness.





LIMITATIONS OF THE STUDY

1. In this study, only academic performance of post graduate students were used which make the results limited.
2. Background information of students' was not consulted during measuring their learning styles.
3. Teachers' teaching styles were not explored which is an important indicator of students' learning styles.
4. Only one subject from each disciplines were included as sample therefore, the results cannot be generalized to the students of other disciplines and area.
5. Descriptive exploratory research method were employed in this study, the results can be generalised by other research method.

CONCLUSION

On the above discussion, the investigator concluded that in modern society everyone wants to become the best and learns in different way that best suit his/her learning needs and they use different styles for learning which enables them to be successful at their academic career. Teachers may using multiple modes of teaching learning styles domain in enhancing the academic achievement. This may require moving their modes of teaching and learn to use a variety of styles, which will positively affect learning. By utilizing a variety of teaching approaches, teachers will reach more students because of the better match between teacher and learner styles.

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Table 1: Sampling Frame

Sr. No.	Discipline	Departments running in P.G programme	No. of students (3 rd semester)
1.	Science	Environmental Science	39
		Nano science	8
		Mathematics	
2.	Social Sciences	Educational studies	40
		National Security Studies	13
		Social Work	17
3.	Languages	English	32
		Hindi	20





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Table 2- Sample Description

Sr. No.	Discipline	Department selected for sampling	No. of students constituting final sample
1.	Science	Environmental Science	30
2.	Social Sciences	Educational Studies	30
3.	Languages	English	30
Total			90

Table 3: Learning Style wise categorization of Academic Performance Score of the Students of Science discipline

	Sr.NO.	Learning Styles						
		Auditory	Visual	Logical	Verbal	Social	Solitary	Kinnesthetic
Performance Scores	1	413	428	427	412	400	396	356
	2	378	409	412	385	340	384	-
	3	356	401	388	385	-	379	-
	4	355	398	383	360	-	-	-
	5	-	389	371	344	-	-	-
	6	-	345	369	343	-	-	-
	7	-	-	363	-	-	--	-
	8	-	-	336	-	-	-	-
Mean Scores		375.5	395	381.1	371.5	370	386.3	356
Overall Mean Score (N ₁ = 30)		404						

Table 4: Learning Style wise categorization of Academic Performance Score of the Students of Social Science

	Sr. NO.	Learning Styles						
		Auditory	Visual	Logical	Verbal	Social	Solitary	Kinnesthetic
Performance Scores	1	408	449	432	423	433	413	-
	2	-	438	418	413	401	-	-
	3	-	434	407	411	387	-	-
	4	-	434	401	400	381	-	-
	5	-	428	399	-	376	-	--
	6	-	425	395	-	-	-	-
	7	-	418	368	-	-	-	-
	8	-	418	-	-	--	-	-
	9	-	413	-	-	-	-	-
	10	-	407	-	-	--	-	--
	11	-	394	-	-	-	-	-
	12	-	383	-	-	-	-	-
Mean Scores		408	420	402.8	411.7	395.6	413	-
Overall Mean Score (N ₂ = 30)		409.13						





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Table 5 : Learning Style wise categorization of Academic Performance Score of the Students of Languages

	Sr.No.	Learning Styles						
		Auditory	Visual	Logical	Verbal	Social	Solitary	Kinnesthetic
Performance Scores	1	326	369	370	345	295	331	-
	2	309	311	324	332	285	313	-
	3	309	309	301	311	-	278	-
	4	-	304	300	310	-	-	-
	5	-	302	288	287	-	-	-
	6	-	295	288	-	-	-	-
	7	-	293	284	-	-	-	-
	8	-	287	283	--	-	-	-
	9	-	285	-	-	-	-	-
Mean scores		314.6	306.1	304.7	317	290	307.3	-

Table 6: Learning Style wise categorization of Academic Performance Score of the Students of Discipline of Science, Social Sciences and Languages

Discipline	Learning styles							Overall Mean score	Total mean score of 90 students
	Auditory	Visual	Logical	Verbal	Social	Solitary	Kinnesthetic		
Mean score of Science	375.5	395	381.1	371.5	370	386.3	356	404	357.03
Mean score of Social Sciences	408	420	402.8	411.7	395.6	413	-	409.13	
Mean score of Languages	314.6	306.1	304.7	317	290	307.3	-	307.46	
No. of students	8	27	23	15	9	7	1	-	



Figure 1: Type of learning Styles





Biochemical and Molecular Characterization of Ahu and Bao Rice Varieties of Majuli District

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ABSTRACT

The agricultural area of North East India contains a vast amount of rice varieties that have potential for providing mineral nutrients as well as carbohydrate. However, the exploration of these mineral infused varieties require attention as several natural varieties are neglected due to the preference of high yielding cultivars among commercial farmers. In this paper some pigmented varieties of rice were analyzed for their mineral nutrition and their genetic diversity is determined with ISSR. Varieties exhibit presence of Zinc and Iron in the analysis.

Keywords: Rice, minerals, Amylose, Zinc, Manganese, Iron, Copper, ISSR, *Oryza sp*

INTRODUCTION

Rice is a major staple food and a mainstay for the rural population and their food security. It is the second most cultivated cereal crop worldwide and is central to the lives of billions of people around the world [1]. Rice belongs to the family Poaceae and Asian rice cultivars are broadly classified into major subspecies *i.e.* *Oryza sativa japonica* and *Oryza sativa indica* [2]. In addition to these major varieties, the minor groups include Aus cultivars of India and Bangladesh, Ashinas varieties of Bangladesh and aromatic basmati varieties of India [3]. Rice varieties show extensive genotypic and phenotypic diversity, resulting in about 120,000 different accessions worldwide [4]. Considerable morphological, ecological and physiological variations exist within each varietal subpopulation owing to selection for adaptations to different agro-climatic conditions [4]. These accessions range from traditional rice landraces preserved by indigenous farmers to the commercially bred cultivars developed during the green





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revolution. Each landrace has particular characteristics; early maturity, adaptation to particular soil types, resistance or tolerance to biotic and abiotic stresses, and in the expected end usage of the grains. India is home to many such landraces and the ones from the states of North Eastern region of the country are especially diverse morphologically and genetically, and are worthy candidates for detailed examination [5]. India is the centre of origin of rice with a total of 88,681 different variety of rice. Studies have shown that, India comprises of 55,615 rice landraces of which 1,171 are wild races and 32,895 are other varieties [6]. Assam alone comprises about 6000 different landraces, which needs to be well characterized for their properties as well as to preserve intellectual property right. Rice is cultivated here on over 65 per cent area under agricultural crops in three different seasons viz., Aus (autumn rice), Aman (winter rice) and Boro (summer rice) [7]. Rice growing areas of north-eastern India were rich in traditional landraces of which many were reported to be tolerant to biotic stress against various pests (gall midge, stem borer, green leaf hopper) and diseases (blast, bacterial leaf blight, rice tungrovirus, bacterial leaf streak) [8] [9] [10] [11]. The pigmented rice cultivars analysed in the present study appear to be a good source of phytochemicals like anthocyanin, phenol, flavonoid and found to have antioxidant activity [12]. Rice is a extensively used material for research purpose however, in Assam detailed study of the rice varieties is a necessity as well as it is fascinating to gather knowledge from local people. It is an vast area for ethnobotany and genetic diversity analysis.

MATERIALS AND METHODS

Collection of seed

Rice varieties were collected from farmers' fields of Majuli district of Assam during 2020-2021. After collection, seeds were dried, kept in separate zip lock bags, and stored in desiccators. During the study, collected seeds of different rice varieties were photographed using a Nikon D7100 digital single lens reflex camera (DSLR) equipped with Tamron 90 mm f/2.8 macro (reproduction ratio of 1:1) lens. For documentation of the size, seeds were photographed along with an OMEGA cm scale. Eight quantitative characters were selected for the present study. The characters include quantitative measurement of seed with husk (termed as seed) and without husk (termed as grain). The traits considered are seed length, seed breadth, seed weight, grain length, grain breadth and grain weight. The length and breadth parameters were recorded using a digital side calliper (Model No: 15-077-958, make Fisher Scientific). The weight parameter was recorded using an electronic balance (Model RS 232, make KERNals, Germany). For each of the variable ten replications were made.

Quantification of Amylose, Zinc, Manganese, Iron and Copper content

Amylose content was determined by the method described by [13]. The mineral solution was prepared according to the method described by [14]. The results were expressed in mg/100g.

Statistical Analysis to identify core groups for seed characteristics

For each of the rice varieties, the variables were finally represented as mean \pm standard error (SE). To find the mean of the replicated data, following formula was used.

$$\bar{x} = \frac{x_1 + x_2 + \dots + x_n}{n}$$

SEM was estimated by the sample estimate of the population standard deviation (sample standard deviation) divided by the square root of the sample size (assuming statistical independence of the values in the sample).

$$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$$





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To find the core clusters of collected rice varieties, using the same set of data, principal component analysis (PCA) and hierarchical clustering was constructed. All the calculations were made by using the statistical software package “Statistical Package for the Social Sciences (SPSS)” (IBM SPSS Statistics or simply SPSS).

EXPERIMENTAL FINDINGS AND DISCUSSIONS

During the study period, a total of 6 rice landraces were collected from the study area Majuli. The races were Ixjoy Ahu, Kola Ahu, Ronga Ahu, Kola amona Bao, Kekoa Bao and Kola Bao. The colour and texture characteristics of the collected rice varieties were recorded. It was found that the varieties have considerable variation for the characteristics under the study. It has been reported that coloured rice varieties are rich in total phenolics, flavonoid and antioxidant contents [15]. Therefore, this record will be of future research interest. The work on quantitative characters exhibit Ronga Ahu rice had the smallest seed length to breadth ratio (1.988 ± 0.06). On the other hand, Kola Ahu (2.839 ± 0.02) and Kekoa Bao (2.283 ± 0.29) have the highest seed length to breadth ratio. Characterization for amylase content revealed that Ixjoy Ahu has the highest Amylose content followed by Amona Bao (20.683 ± 1.49) and Kola Amona Bao (20.683 ± 1.49). Kola Ahu (13.549 ± 0.86) has the lowest amylase content. Characterization for zinc content showed that Kekoa Bao had the highest zinc content followed by Kola Ahu (1.720 ± 0.44) and Ronga Ahu (1.170 ± 0.06). For Manganese, Kola Ahu (1.160 ± 0.05) and Ronga Ahu (1.490 ± 0.06) showed the highest values whereas, the Kekoa Bao has the lowest Mn Content (0.560 ± 0.04).

Iron (Fe) is another micronutrient essential for human growth and development. Quantification for iron content revealed that, Ixjoy Ahu has the highest seed Fe content of 1.449 ± 0.05 (mg/100g). Quantitative characteristics for rice seed has a great importance in determining the total weight of rice *vis a vis* production/hectare of land. Therefore, identification of core groups of local rice varieties for seed length can have a great importance for considering these varieties as sources of genetic material for new improved varieties. During this study, for the quantitative character rice seed length, nine sub groups could be identified. To incorporate into breeding experiments, these genotypes can be of substantial importance. Cluster analysis (UPGMA) was generated by computing both polymorphic as well as monomorphic markers to construct the dendrogram. All the clusters could be grouped as one major cluster and one minor cluster. It was found that Kokua Bao and Amona Bao formed a minor cluster by forming a separate group. The major cluster comprised of Kola Amona Bao, Ronga Ahu, Ixjoy Ahu and Kola Ahu. In the major cluster, Ronga Ahu, Ixjoy Ahu and Kola Ahu emerged as sister groups from Kola Amona Bao.

CONCLUSION

From the biochemical results Zinc and Iron content of the rice varieties were confirmed. These varieties can serve as nutritious food for Zinc and Iron deficient people. These rice varieties will be of great importance as they can be used for fabrication of rice based food industry. Coloured rice varieties are also important source of antioxidants and several other micro and macronutrient supplements of human diet. The findings of this research work contributed towards documentation of coloured rice varieties of two different regions of Assam, which can be further utilized for studies related to nutritional supplementation for the people suffering from malnutrition.

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Table 1: Variation of quantitative characteristics of the rice seeds among the collected varieties

N o.	Coloured Varieties	Length (mm) ±SD	Breadth (mm) ±SD	L/B ratio± SD	Amylos e (g) ±SD	Zn (mg/100g) ±SD	Mn (mg/100g) ±SD	Fe (mg/100g) ±SD	Cu (mg/100g) ±SD
1	Ixjoy Ahu	5.267±0.3 0	2.533±0.0 5	2.078± 0.07	25.673±3. 17	1.439±0.2 7	1.109±0.2 9	1.449±0.0 5	0.763±0.1 7
2	Kola Ahu	5.867±0.1 5	2.067±0.0 5	2.839± 0.02	13.549±0. 86	1.720±0.4 4	1.160±0.0 5	0.282±0.1 3	0.477±0.0 4
3	Ronga Ahu	4.833±0.1 5	2.433±0.1 1	1.988± 0.06	18.576±0. 59	1.170±0.0 6	1.490±0.0 6	0.824±0.1 4	0.678±0.1 0





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4	Amona Bao	5.800±0.3 0	2.633±0.1 5	2.206± 0.14	20.683±1. 49	1.218±0.4 6	1.016±0.1 3	0.855±0.3 4	0.566±0.0 9
5	Kekoa Bao	5.933±0.7 5	2.600±0.1 0	2.283± 0.29	19.866±0. 51	1.858±0.1 4	0.560±0.0 4	0.299±0.0 7	0.431±0.1 1
6	Kola Amona Bao	5.800±0.3 0	2.633±0.1 5	2.206± 0.14	20.683±1. 49	1.218±0.4 6	1.016±0.1 3	0.855±0.3 4	0.566±0.0 9

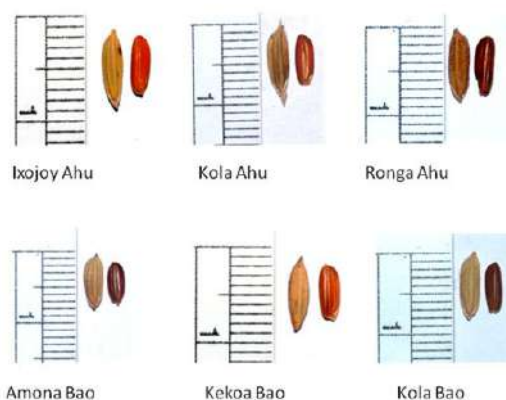
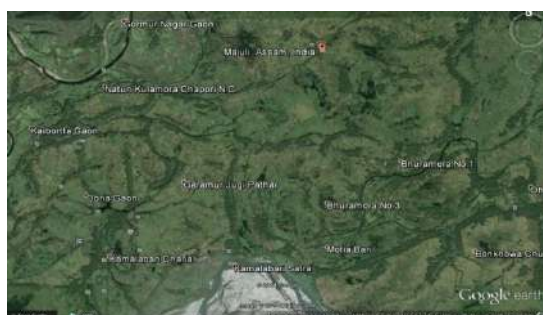


Figure 1: Satellite imagery of the location under study

Plate 1: Photographic documentation of the collected rice varieties of Assam

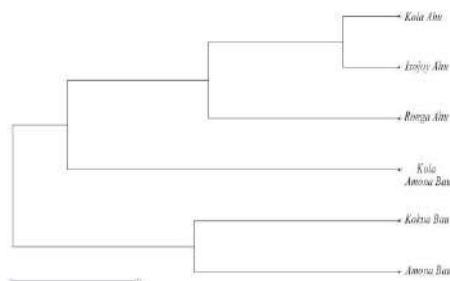


Figure 2: Genetic Distance based hierarchical cluster (UPGMA) tree showing the relationship between the collected genotypes of different varieties of rice.





RESEARCH ARTICLE

Analysing Disaster Risk Reduction Approach And Opportunities for Enhanced Relations In The Indian Ocean - An Analytical Study of India's Soft Power Dynamics In The Region

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ABSTRACT

The paper presents a comprehensive analysis of India's approach to disaster risk reduction (DRR) in the Indian Ocean region, examining the associated opportunities for strengthening diplomatic ties. The study delves into the nuanced dimensions of India's soft power dynamics within the context of DRR initiatives. By scrutinizing India's engagement with disaster-prone areas in the Indian Ocean, the research explores how the nation's humanitarian efforts contribute to enhanced regional relations. The analysis encompasses India's involvement in international humanitarian organizations, its financial commitments, and the strategic allocation of resources for DRR. By shedding light on India's soft power influence in the context of disaster management, this study aims to provide valuable insights into the potential for strengthened diplomatic relationships in the Indian Ocean region.

Keywords: Indian Ocean, Disaster Risk Reduction, Soft Power, India, Regional Cooperation, Development, Disaster Management

INTRODUCTION

Historically, Western nations have traditionally taken the lead in disaster relief efforts. Nevertheless, the growing influence of countries in the Global South, such as India, has led to the development of dual strategies in disaster management. This involves enhancing domestic capabilities while also becoming an emerging donor that actively contributes to disaster relief efforts, particularly in the Indian Ocean Region. The Indian Ocean Region (IOR) is often referred to as the "World's Hazard Belt" due to its susceptibility to various disasters, whether natural or human-



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induced ("Disaster Risk Management – Indian Ocean Rim Association – IORA," n.d.) . Natural disasters in the form of Climatological events (such as cyclones and droughts), Geological and Tectonic occurrences (such as earthquakes and tsunamis), and Hydrological incidents (including floods and tidal surges) are frequent and recurring phenomena in this area. The Indian Ocean basin is indeed a hot spot for natural disasters, and the reasons behind it are a fascinating blend of geographical, geological, and climatic factors. The various reasons for the disasters in the region can be given as :

Tectonic Activity

Plate Convergence The Indian Ocean sits at the crossroads of three major tectonic plates – the African, Indian, and Antarctic plates. Their constant movement along convergent boundaries often triggers:

Earthquakes The subduction of the Indian plate beneath the Eurasian plate along the Sunda Megathrust generates frequent earthquakes, some strong enough to trigger tsunamis.

Volcanic Eruptions The collision of plates also fuels volcanic activity along island chains like Indonesia and the Maldives.

Warm Ocean Waters

Tropical Climate The Indian Ocean lies predominantly within the tropics, bathed by warm sunshine and receiving ample rainfall. This warm water acts as a breeding ground for powerful:

Tropical Cyclones The Coriolis force and high sea surface temperatures (SSTs) fuel intense cyclonic storms like hurricanes and typhoons, especially during the monsoon season.

Tsunamis Underwater earthquakes or landslides in the ocean floor can trigger tsunamis, sending devastating waves towards the coasts.

Monsoonal Influences

Seasonal Wind Reversals The Indian Ocean experiences dramatic seasonal wind reversals known as monsoons. These strong winds bring torrential rains, leading to:

Floods Low-lying coastal areas and river basins are particularly vulnerable to flash floods and inundation during the monsoon months.

Landslides In mountainous regions, heavy rainfall can trigger landslides, causing infrastructure damage and loss of life.

Climate Change

Rising Sea Levels Global warming is causing sea levels to rise, threatening coastal communities with:

Erosion Increased wave action and rising water levels erode coastlines, displacing communities and damaging infrastructure.

Salinization Intrusion of saltwater into freshwater sources and agricultural land can render them unusable.

Vulnerability of Coastal Communities

Dense Populations Many countries bordering the Indian Ocean are densely populated, with millions living in close proximity to the coast. This increases the risk of human casualties and economic losses during natural disasters.

Limited Resources Developing nations often lack the financial and technological resources to effectively prepare for and respond to natural disasters, exacerbating their impact. Understanding these scientific reasons is crucial for mitigating the impact of natural disasters in the Indian Ocean region. By investing in early warning systems, disaster preparedness programs, and sustainable coastal development, communities can become more resilient and adapt to the ever-changing environment. It's important to remember that while the Indian Ocean faces significant natural hazards, its people have also demonstrated remarkable resilience and adaptation in the face of adversity. By understanding the science behind these events and working together, we can build a safer and more sustainable future for the region (*Sunhak Peace Prize*, n.d.).





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Rank wise Countries with disaster risks in Indian Ocean

Rank	Country	Risk
1.	Philippines	46.86
2.	Indonesia	43.50
3.	India	41.52
6.	Myanmar	36.16
7.	Mozambique	34.61
9.	Bangladesh	27.29

Source- World Risk Report 2023

Disaster management in the Indian Ocean is a complex challenge, given the region's diversity and the interconnectedness of its risks. However, there are a number of important initiatives underway to improve disaster preparedness, response, and recovery in the region. According to the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP), approximately 50% of the natural disasters in the region are attributed to climatic and seismic factors (Limo, 2014). Rapid population growth, combined with the rise in sea levels and the escalating intensity of tropical cyclones, will result in increased levels of human vulnerability and regional insecurity. By 2030, the Indian Ocean rim is expected to have the highest population density globally, with approximately 340 million people residing in coastal hazard zones. Currently, the Bay of Bengal is responsible for over 80 percent of all cyclone-related fatalities, despite experiencing only 5 percent of the world's cyclones. Additionally, the heightened frequency and intensity of heat waves will have significant repercussions for human health. India being one of the responsible country in the region, over the past twenty years, India's approach to disaster management has undergone a significant transformation. Initially reactive and focused primarily on flood and drought relief, it has evolved into a proactive and holistic strategy. This comprehensive approach now encompasses prevention, mitigation, preparedness, capacity building, risk reduction, technological advancements, community involvement, and resilience against a broader spectrum of hazards. Holistic disaster management entails the integration of disaster risk reduction (DRR) into policies, institutions, infrastructure, and logistics.

This integration aims to develop effective tools for preemptive and efficient action. India has formulated DRR policies involving input from domain experts, various levels of government, and local communities. Furthermore, the country has enhanced its response capabilities through international collaborations and coordinated risk reduction efforts at both national and local levels. Recognizing the complexity of disaster management, India emphasizes the need for well-considered policies, a robust legal framework, specialized institutions, efficient administrative mechanisms, and proactive engagement from stakeholders. The effectiveness of these elements depends on their seamless integration. The policies, institutions, and logistics of disaster management are deemed as crucial as the actual rescue equipment. They play a vital role in disaster handling, reaching remote areas, and determining the tools for effective and efficient action. The involvement of disaster management practitioners in policy design and development is equally crucial, as their expertise ensures a deep understanding of the complexities involved and optimal coordination of policies, institutions, and logistics.

METHODOLOGY

The research employs Analytical research methodology which includes literature review strategy to gather and examine pertinent academic resources, reports, peer-reviewed papers, conference presentations, and other related credible publications. A blend of online databases and academic libraries has been employed to conduct an exhaustive examination of the existing landscape. The gathered information has been analysed through thematic analysis.



**Talha Latief Tantray et al.,****Objectives**

The study analyzes disaster risk reduction (DRR) approaches and opportunities for enhanced relations in the Indian Ocean, with a focus on India's soft power dynamics in the region, could be multifaceted and comprehensive. The objectives of the study are:

1. Evaluate the existing disaster risk reduction strategies implemented by India in the Indian Ocean region.
2. Examine the effectiveness of these strategies in mitigating and responding to disasters.
3. Explore how disaster management efforts can serve as a platform for building positive relationships with neighboring countries Identify potential opportunities for India to strengthen diplomatic ties and collaborations in disaster risk reduction within the Indian Ocean region.
4. Analyze India's participation in regional and multilateral forums focused on disaster risk reduction in the Indian Ocean.

India's Disaster Relief Initiatives in the Indian Ocean Region (IOR)

Due to its substantial size, central geographic location in the region, and borders with nearly every country in the vicinity, India holds a crucial position among its neighbors. This distinctive position, combined with its well-equipped armed forces, allows India to play a significant role in Humanitarian Aid and Disaster Relief Initiatives (Sharma, 2017). The emergence of the concept of India as a "first responder" underscores the country's readiness and capacity to take on the role of a leading power. Since 2001, India has been actively strengthening its capacity within the region, engaging with all stakeholders on an institutional level. India's approach to its neighbors has been characterized by health diplomacy and the provision of humanitarian aid during natural disasters. The country's increased financial resources and a growing sense of international and regional responsibilities have been driving forces behind these efforts. The Covid-19 pandemic took the region by surprise, posing immense challenges with lockdowns, insufficient medical infrastructure, and difficulties in ensuring social distancing. The Global Health Security (GHS) 2021 report reveals that countries across all income levels are inadequately prepared for future epidemic and pandemic threats, with South Asia performing particularly poorly. The pandemic has had a severe economic impact on the region. India's growing leadership in disaster management has strengthened its soft power and enabled opportunities to enhance relations with IOR countries. India has provided disaster relief to countries in the IOR bilaterally, including after the 2004 Indian Ocean tsunami, Cyclone Mora in Myanmar in 2017, and Cyclone Idai in Mozambique in 2019. India deployed naval ships carrying humanitarian aid and medical teams for relief operations after Cyclone Idai in Mozambique in 2019. It also sent additional ships with relief materials, medicines, food, and water. During Cyclone Diane in Madagascar in 2020, India dispatched naval ship INS Airavat carrying disaster relief stores. It also handed over relief materials and medicines to local authorities. India's relief efforts have focused on countries in its immediate neighborhood and the Indian Ocean region (Luiz de Freitas Vieira & Almeida C6, 1997)

Regional Cooperation on Disaster Management

India has provided support through multilateral channels like World Food Programme and has approved the United Nations (UN) as the principal coordinating body for disaster relief at the regional level. According to statistics from the World Risk Report 2023, India has actively engaged in regional disaster management exercises, including the South Asian Annual Disaster Management Exercise (SAADMEx) and the BIMSTEC Disaster Management Exercise. An action plan and criteria for humanitarian assistance and disaster relief in the region are also being developed by India, which holds the position of chair for Indian Ocean Rim Association (IORA) Working Group on Disaster Risk Management. Additionally, the nation is forming partnerships with the BIMSTEC Centre for Weather and Climate and IORA to improve its capabilities in disaster risk reduction. India has been a key contributor to global humanitarian efforts over the years through a number of organisations, including Caritas, the International Committee of the Red Cross (ICRC), the World Food Programme (WFP), and the Central Emergency Response Fund (CERF). With a US\$ 2.4 billion budget for direct overseas aid in the 2021–22 fiscal year, India has emerged as a prominent non-Western donor.



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Furthermore, India has extended a considerable direct credit line totaling thirty-six billion dollars to a number of other countries in support of development initiatives (Upadhyay, 2021). The South Asian Association for Regional Cooperation (SAARC) suggested in 2006 that SAARC Disaster Management Centre (SDMC), with its headquarters located in New Delhi, be established in the wake of the 2004 tsunami. A disaster management framework that is in line with the Hyogo Framework for Action 2005–2015 has been accepted by the SDMC, which has also developed a number of Road Maps that cover many disaster management topics. SAARC leaders are still unable to agree on the establishment of a fast response team specifically for disaster management in spite of their best efforts. India has been a key contributor to the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) countries. These countries frequently experience cyclones and tsunamis, necessitating cooperative approaches to risk mitigation and crisis management. India has been concentrating on "Environment and Disaster Management" in the region since 2015. This is in line with its foreign policy goal of improving connectivity with neighbouring states by working together on Humanitarian Assistance and Disaster Relief (HADR). Additional HADR-related collaborations within BIMSTEC have been made possible by India's maritime cooperation policy, Security and Growth for All in the Region (SAGAR).

All seven of the member states of BIMSTEC participated in the first Disaster Management Exercise (DMEx), which took place in October 2017. It included a Table Top Exercise (TTX), Field Training Exercises (FTXs) on earthquake and flood, and an After Action Review (AAR). In February 2020, there were simulated flood-related situations at the second BIMSTEC DMEx, which involved participants from five member nations. Along with holding a workshop on building disaster-warning systems, BIMSTEC also launched a Centre for Weather and Climate in 2018 (Upadhyay, 2021). India regularly participates in the Indian Ocean Rim Association (IORA), a founding member organisation whose objective includes disaster risk management. The association's mission is to strengthen institutions and capacities while encouraging collaboration and coordination amongst authorities, professionals, and stakeholders in the area. With the aim of giving member states a clear road map for forming an IORA-Working Group on Disaster Risk Management (WGDRM), the first IORA Expert Group Meeting on disaster risk management took place in 2021. In a similar vein, India organised the Indian Ocean Naval Symposium with a focus on regional collaboration in disaster relief and humanitarian assistance (HADR).

India's disaster management approach is implemented through a variety of mechanisms, including:

India's Vision of SAGAR and Focus on Capacity Building

India's approach to disaster management in the IOR is guided by its vision of SAGAR - Security and Growth for All in the Region. It focuses on developing knowledge, building capacities, and enhancing cooperation to respond effectively to disasters in the region. India is encouraging partnerships between IOR countries and institutions to boost capabilities for disaster preparedness, mitigation and recovery. It aims to facilitate information exchange, training programs, system development, and sharing of best practices on disaster risk reduction. India's approach to the Indian Ocean aligns with the vision of SAGAR (Security and Growth for All in the Region). SAGAR encompasses diverse yet interconnected elements, including strengthening economic and security collaboration in coastal areas, building capabilities to protect both land and maritime territories, pursuing sustainable regional development, fostering the Blue Economy, and advocating for joint efforts to address non-traditional threats such as natural disasters, piracy, terrorism, and more. India's strategy for disaster management in the Indian Ocean is guided by the following principles:

1. **Proactive** India focuses on disaster risk reduction and preparedness, rather than just reacting to disasters after they occur. This includes identifying potential hazards, assessing vulnerabilities, and developing mitigation measures.
2. **Comprehensive** India's disaster management approach covers all phases of the disaster management cycle, including preparedness, response, recovery, and rehabilitation.
3. **Multi-sectoral** India recognizes that disaster management requires the involvement of all stakeholders, including government agencies, civil society organizations, and the private sector.





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4. **Regional** India cooperates with other countries in the Indian Ocean region to share information and best practices, and to coordinate disaster response efforts.

Strengthening India's Soft Power through Disaster Management initiatives in the Indian Ocean Region (IOR)

India's growing leadership in disaster management has strengthened its soft power and influence in the region. Its prompt response as a "first responder" has generated goodwill among Indian Ocean Region (IOR) countries. This has enabled India to emerge as a net security provider in the Indian Ocean region. It has also presented opportunities for India to forge stronger maritime security cooperation with regional countries. Overall, India's approach has allowed it to project itself as a responsible leader committed to the region's humanitarian and environmental security. India's initiatives in Humanitarian Assistance and Disaster Relief (HADR) demonstrate a determination to be a leading provider in the region. While HADR is typically a non-controversial aspect of the agenda, it serves as a tool for fostering stronger connections with neighbouring nations and reviving regional cooperation. Collaborative efforts, such as the PANEX-21 HADR exercises conducted by BIMSTEC, offer opportunities to address new challenges and refine existing relief and rescue operations. Given the increasing occurrence of large-scale disasters transcending national borders, there is a growing imperative for regional cooperation in Disaster Management. To address this need, it is crucial to establish a framework for the "One Region-One Response" policy. This approach not only encourages regional cooperation through the sharing of information, experiences, and best practices but also serves as a catalyst for the economic recovery of the entire region (Sharma, 2017). Besides, India's disaster management approach is implemented through a variety of other mechanisms, which includes:

1. *The Disaster Management Act, 2005*: This Act provides the legal framework for disaster management in India. It establishes the National Disaster Management Authority (NDMA) as the apex body for disaster management, and mandates the creation of State and District Disaster Management Authorities.
2. *The National Policy on Disaster Management, 2009*: This policy outlines India's overall approach to disaster management, with a focus on disaster risk reduction and preparedness.
3. *The Indian Ocean Rim Association (IORA)*: India is a founding member of IORA, which is a regional forum for cooperation on a range of issues, including disaster management.
4. India has also developed a number of specific disaster management initiatives for the Indian Ocean region, such as:
5. *The Indian Ocean Disaster Risk Reduction Network (IODRRN)*: This network provides a platform for disaster management experts in the Indian Ocean region to share information and best practices.
6. *The Indian Ocean Tsunami Warning System (IOTWS)*: This system provides early warnings of tsunamis to countries in the Indian Ocean region.
7. *The Indian Ocean Disaster Assistance Rapid Response Team (IDART)*: This team is deployed to provide rapid response and assistance to countries in the Indian Ocean region that are affected by disasters.
8. India's disaster management approach in the Indian Ocean has been praised by the international community. India is now recognized as a leading regional player in disaster management, and its expertise is sought by other countries in the region.

Here are some cases of India's disaster management interventions in the Indian Ocean region:

Case1 – Madagascar (2020)

Madagascar is the Indian Ocean's biggest and most populated island. It lies in the South Western Indian Ocean. Poverty, starvation, and malnourishment are just a few of the issues that Madagascar, a developing nation, deals with. Along with being susceptible to cyclones, floods, and droughts, the nation is also susceptible to other natural calamities. In January 2020, the island nation was hit by Cyclone Diane. In order to help the people of Madagascar who were impacted by the destruction caused by the cyclone, the Indian Naval Ship Airavat was redirected to Madagascar on January 26, 2020, as part of "Operation Vanilla". (Navy) The Indian Navy was the first international respondent to carry out Humanitarian Assistance and Disaster Relief (HADR) missions in the humanitarian catastrophe in Madagascar. (Defence, 2020) INS Shardul visited the Port of Antsiranana in March 2020 with 600 tonnes of rice in order to provide immediate help to the people of Madagascar affected by flooding. (Embassy of



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India, 2022) The INS Jalashwa transported 1000 metric tonnes of rice and 100,000 tablets of Hydroxychloroquine to the island nation in March 2021 to assist with the drought crisis in South Madagascar. In September 2022, humanitarian aid of 5000 metric tonnes of rice was provided by India to the storm and flood affected Madagascar. (Embassy of India, 2022)

Case 2 – Mauritius (2020)

Mauritius is an island nation in the Western Indian Ocean. Due to historical, demographic, and cultural factors, India and Mauritius have maintained close and long-standing ties. Of the 1.2 million people living on the island, individuals of Indian descent make up around 70%. (High Commission of India P. L., 2023) In July 2020, a Japanese owned ship named MV Wakashio ran aground at Pointe d'Esny on the coast of Mauritius after which the oil started leaking and caused led to the oil spill. (Khadka, 2020) The Indian government provided over 30 tonnes of technical equipment and material to Mauritius through Indian Air Force aircraft in response to the Mauritian government request for help in handling the environmental crisis. These supplies supported Mauritius's efforts to contain the oil spill and salvage it. The Indian Coast Guard (ICG) had also sent a Technical Response Team of 10 members to Mauritius in order to provide the required operational and technical support at the site. The team members were specialised in handling oil spill mitigation procedures (Ministry of External Affairs, 2020).

Case-3 Mozambique (2019)

Mozambique, an Indian Ocean coastal nation was struck by Cyclone 'Idai' in March 2019. Indian Naval ships INS Sujata and INS Shardul along with Indian Coast Guard Ship ICGS Sarathi reached Port Beira and provided necessary support to the local administration. They supply food, water, blankets, and other necessities for relief. (Navy, 2019) In addition to this, another ship INS Magar reached Mozambique with supplies for everyday needs, clothes, medications, dry goods, and ready-to-eat meals. 400 tonnes of rice and 500 kg of medicines relevant to the epidemic were also provided by the ship. (High Commission of India, 2019) Following a food scarcity brought on by natural disasters in 2017, Mozambique received \$10 million from India as humanitarian aid for food grains (Ministry of External Affairs, 2019).

Case 4 –Maldives (2014)

India and the Maldives are neighbours with a shared maritime border. Strategic, economic, and military collaboration between India and Maldives has been warm and close. India keeps helping to keep the island nation secure. India responded quickly to the Maldives' call for aid during the Male Water crisis, which broke out on December 4, 2014, as a result of a fire in the Male Water and Sewerage Company complex. Indian aircraft made several sorties to bring 375 tonnes of drinking water to the inhabitants of Male during which the first aircraft arrived in Male within 12 hours of the Maldives government's request. Additionally, two ships of Indian Navy, INS Deepak and INS Sukanya, arrived at Male and brought with them about 2000 metric tonnes of water. (Operation Neer : Indian assistance to Maldives during Male Water Crisis) India's disaster management approach in the Indian Ocean is a reflection of its commitment to being a good neighbor and a responsible global citizen. While it is evident that climate change poses a threat to the stability of the entire Indian Ocean region, scientists emphasize the need for further research to comprehensively understand the specific impacts of climate change on the region.

CONCLUSION

India has established itself as a capable first responder and net security provider in the Indian Ocean region through its bilateral and regional disaster relief efforts. Its SAGAR vision and focus on capacity building has strengthened its soft power. By leading disaster management initiatives, India has enhanced cooperation and relations with IOR countries, unlocking further opportunities for growth and security in the region. India's efforts in disaster relief have significantly expanded over the past two decades. This development can be attributed to India's emergence as an economic powerhouse, increased involvement in neighboring regions, and a strong commitment to being the





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primary responder to disasters in the area. Disaster response, generally considered uncontroversial, holds the potential to enhance diplomatic ties with neighbouring countries.

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Open and Closed Bisets in Topological Bispaces

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ABSTRACT

In this study, we define a semi open and semi closed bisets, pre-open and pre-closed bisets, obtain some of their properties. Next, we introduce the concepts of generalized closed sets in Topological bispaces, we discuss some of their properties and investigate the relations between the associated topology.

Keywords: semi-open and semi-closed bisets, pre-open and pre-closed bisets, G-star-S-closed bisets, Generalized pre-open biset [simply, GPOB].

INTRODUCTION

Let (X_B, τ) be a topological space and let $A \subseteq X$. Then the closure of A and the interior of A will be denoted by $cl(A)$ and $int(A)$ respectively. A subset A of a topological space (X_B, τ) is said to be semi-open [3] if there exists an open set U such that $U \subset A \subset cl(U)$. The complement of a semi-open set is called semi-closed [2]. On the other hand, the idea of semi-open set was introduced by Levine [3]. In 1970, Levine [3] first considered the concept of generalized closed (briefly, g-closed) sets. Generalized semi-open sets were defined. The concepts of pre-open set were given by Kelly [1] in his book General topology. $scl(A) - sint(A)$ is called the semi-frontier of A [3] and is denoted by $sFr(A)$. $sInt(X - A)$ is said to be semi-exterior of A [3] and is denoted by $sExt(A)$. In this paper, we utilize the concepts of pre-open and





pre-closed bisets in topological bispace. Besides, we prove that some of its properties. Moreover, we define and study the notions of generalized closed biset, Generalized- star-s-closed bisets (briefly, G-star-s-closed bisets) Generalized pre-open Biset[Briefly, GPOB] GPOB-compact, strongly compact biset and investigate its basic property.

Preliminaries

As the preliminaries definitions, which is necessary to study [1],[5],[3],[6],[7].

Definition 2.1

Let A_B be a subbisets of a topological bispace X_B . Any point $a_B \in A_B$ is said to be interior of A_B , if a_B belong to an open bisets F_B contained in A_B .

That is, $a_B \in F_B \subset A_B$.

The set of interior points of A_B is denoted by $\text{int}(A_B)$ or A_B° , which is called the interior of A_B .

Definition 2.2

Let A_B be a subbisets of a topological bispace X_B . The closure of A_B is defined as the intersection A_B . the closure super bisets of A_B . the closure of A_B is denoted by $\text{cl}(A_B)$ or $\overline{A_B}$.

Definition 2.3

Let (X_B, τ) be a topological bispace and A_B be a subbisets of X_B and then A_B is said to be semi open bisets whenever $A_B \subseteq \text{cl}[\text{int}(A_B)]$ and semi closed whenever $\text{cl}[\text{int}(A_B)] \subseteq A_B$.

Definition 2.4

Let (X_B, τ) be a topological bispace and A_B be a subbisets of X_B , then if A_B is called pre-open biset if $A_B \subseteq \text{cl}[\text{int}(A_B)]$.

That is, a pre-open biset is a biset which is contained in interior of its closure.

The family of all pre-open biset in the topological bispace is denoted by $F[\text{POB}(X_B)]$.

Definition 2.5

A subbisets A_B of a bispace X_B is generalized preopen bisets (briefly, GPOB's) if $\text{cl}[A_B] \subseteq U_B$ whenever U_B is a pre-closed subbisets such that $A_B \subseteq U_B$. Complements of GPOB's are called generalized pre-closed bisets (briefly, GPCB's).

The collection of GPCB's in X_B are denoted by GPCBs (X_B, τ)

Definition 2.6

Let (X_B, τ) be topological bispace and $[A_B] \subseteq X_B$. Then A_B is called a pre-closed biset if $\text{cl}[\text{int}(A_B)] \subseteq A_B$.

That is, a pre-closed biset is a biset which is contains closure of its interior.

The family of all pre-closed biset in topological bispace is denoted by $F[\text{PCB}(X_B)]$.

Definition 2.7

If (X_B, τ) is a topological bispace. A subbisets of topological bispace is called Generalized closed biset [simply, GCB].

If $\text{cl}(A_B) \subseteq U_B$ whenever $A_B \subseteq U_B$ and U_B is open in X_B .

Definition 2.8

Let (X_B, τ) be a topological bispace and A_B be a subbisets of X_B and then A_B is defined as semi generalized closed bisets [simply, SGCB] whenever $\text{scl}[A_B] \subseteq U_B$ and U_B is semi-open in X_B .

Definition 2.9

Let (X_B, τ) be a topological bispace and A_B be a subbisets of X_B and then A_B is defined as

1. α –open biset whenever $A_B \subseteq \text{int}[\text{cl}[\text{int}(A_B)]]$ and α –open biset whenever $\text{cl}[\text{int}(\text{cl}(A_B))] \subseteq A_B$.
2. Semi pre-open biset whenever $A_B \subseteq \text{int}[\text{cl}[\text{int}(A_B)]]$ and semi – open closed biset whenever $\text{int}[\text{cl}(\text{int}(A_B))] \subseteq A_B$.
3. Weakly closed biset [briefly, w-closed biset] whenever $\text{cl}(A_B) \subseteq U_B$ and U_B is semi- open biset in X_B .
4. Weakly generalized closed biset [WG -closed biset] whenever $\text{cl}[\text{int}(A_B)] \subseteq U_B$ and U_B is open biset in X_B .
5. Regular open biset whenever $A_B = \text{int}[\text{cl}(A_B)]$ and Regular closed biset whenever $A_B = \text{cl}[\text{int}(A_B)]$
6. Regular α – open biset [simply, α – open biset] whenever there is a regular open biset U_B such that $U_B \subseteq A_B \subseteq \text{acl}(U_B)$.
7. Regular semi open whenever there is a regular open biset U_B such that $U_B \subseteq A_B \subseteq \text{cl}(U_B)$.
8. Generalized α –closed biset [briefly, $G\alpha$ -closed biset] whenever $\text{acl}(A_B) \subseteq U_B$ and U_B is semi- open biset in X_B .
9. α –Generalized closed bisets [simply, αG -closed biset] whenever $\alpha - \text{cl}(A_B) \subseteq U_B$ and U_B is open in X_B .





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10. Regular w - closed biset (simply, $r w$ - closed biset) whenever $\alpha - cl(A_B) \subseteq U_B$ and U_B is regular semi open in X_B .

11. Strongly G – closed biset whenever $\alpha - cl(A_B) \subseteq U_B$ and U_B is $G s$ - open biset.

The class of all G - star – s -closed bisets in a topological bispace (X_B, τ) is denoted by $G - star - s - CB(X_B, \tau)$.

The complements of the above mentioned closed sets are their respective open bisets.

Remarks 2.10

The set of real space \mathbb{R} with usual topology \mathbb{J} is always a pre-open biset.

That is $\mathbb{R} \in \mathbb{J}$.

Definition 2.11

A subbiset A of a topological bispace (X, τ) is said to be dense biset in X if either belongs to A or else is arbitrary close to a member of A .

That is, A is dense in X if the smallest closed subbiset of X containing A is X itself.

3 Pre-open biset in topological bispace

In this section, (X, τ) is always denote topological bispace on which no separation axioms are assumed, unless otherwise mentioned. When A is a subbiset of (X_B, τ) then $cl(A_B)$ and $int(A_B)$ are denoted by closure and interior of A_B in topological bispace.

Proposition 3.1

The empty set \emptyset is always a pre- open biset in real space with the usual topological bispace

Proof

Let $X_B = \emptyset$ and $cl(\emptyset) = \emptyset$ and $int[cl(\emptyset)] = int(\emptyset) = \emptyset$

So that, $int[cl(\emptyset)] = \emptyset$ and $\emptyset \subseteq \emptyset$.

Hence $X_B \subseteq int[cl(X_B)]$

Therefore, the empty set \emptyset is always a pre- open bisets in (X_B, τ) .

Proposition 3.2

Every open biset is always a pre- open biset in the real space with the usual topological bispace.

Proof

Let $X_B =]a, b[U, 1, 2[$

Then $cl(]a, b[U, 1, 2[) = [a, b] \cup [1, 2]$

$int\{cl(]a, b[U, 1, 2[)\} = int\{[a, b] \cup [1, 2]\}$

$=]a, b[U, 1, 2[$

$int\{cl(]a, b[U, 1, 2[)\} =]a, b[U, 1, 2[$

$X_B \subseteq int\{cl(X_B)\}$

Therefore, every open bi interval is always as pre-open biset in (X_B, τ) .

Hence Every open biset is always a pre- open biset in the real space with (X_B, τ) .

Proposition 3.3

Every open biset is not a pre- open biset in the real space with the usual topological bispace.

Proof

Let $X_B = [a, b] \cup [0, 3]$

Then $cl([a, b] \cup [0, 3]) = [a, b] \cup [0, 3]$

$int\{cl([a, b] \cup [0, 3])\} = int\{[a, b] \cup [0, 3]\}$

$=]a, b[U, 0, 3[$

$int\{cl(]a, b[U, 0, 3[)\} \not\subseteq]a, b[U, 0, 3[$

$X_B \not\subseteq int\{cl(X_B)\}$

Therefore, every closed bi-interval is not a pre-open biset in the real space usual closed interval is always a closed set in real space.

Hence every, closed biset is not a pre- open biset in the real space with (X_B, τ) .

Remarks

Every half open bi interval is not a pre- open biset in the real space with (X_B, τ) .

Proposition 3.4

The union of two pre- open biset in the topological bispace.

Proof

By the proposition 1, since every open intervals in the pre-open biset.





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Let $G_B = \{]a, b[U]1,2[\} \cup \{]b, c[U]2,3[\}$

We have $a < b < c$ & $1 < 2 < 3$

$= \{]a, c[U]1,3[- (\{b\}U\{2\})$

And $cl(G_B) = cl(\{]a, c[U]1,3[- (\{b\}U\{2\}) \}) = \{]a, c[U]1,3[\}$

and $int[cl(G_B)] = int[\{]a, c[U]1,3[\}] =]a, c[U]1,3[$

and $\{]a, c[U]1,3[- (\{b\}U\{2\}) \} \subseteq]a, c[U]1,3[$

hence $G_B \subseteq int[cl(G_B)]$

therefore, the union of two pre-open biset is also a pre-open biset in (X_B, τ) .

Proposition 3.5

The intersection of two pre-open biset is always pre-open biset in the topological bispace.

Proof

Same proof as above proposition (3.3).

Remarks

1. The intersection of arbitrary collection of pre-open biset is not a pre-open biset in the topological bispace.
2. The indiscrete bispace is always a pre-open biset in the topological bispace.
3. The discrete bispace is always a pre-open biset in the topological bispace.

4 G – star – s – closed biset in Topological bispace

Definition 4.1

A subbisets A_B of X_B is called a G – star – s- closed biset if $scl(A_B) \subseteq U_B$ whenever $A_B \subseteq U_B$ and U_B is G s – open biset.

The class of all G – star – s- closed biset in (X_B, τ) is denoted by $G - star - s - CB(X_B, \tau)$.

The complement of G – star – s- closed biset is a G – star – s- open biset.

Theorem 4.2

Every closed biset X_B in G – star – s- closed biset in X_B but not conversely.

Proof Assume that A_B be a closed biset in X_B . Let U_B be a GS-open biset such that $A_B \subseteq U_B$. since, A_B is closed, that is, $cl(A_B) = A_B$, $cl(A_B) \subseteq U_B$.

But $scl(A_B) \subseteq cl(A_B) \subseteq U_B$.

Therefore, $scl(A_B) \subseteq U_B$.

Hence A_B is G – star – s – $CB(X_B, \tau)$.

The converse of the above theorem need not be true as seen from the following examples.

Example 4.3

Let $X_B = \{ \{a, b, c\} \cup \{1,2,3\} \}$ with $\tau = \{ \emptyset, \{a\}, \{a, b, c\} \} \cup \{ \emptyset, \{1\}, \{1,2,3\} \}$

The bisets $\{b\}, \{c\}$ and $\{2\}, \{3\}$ are G – star – s – CB but not closed biset.

Theorem 4.4

Union of two G – star – s- closed biset in G – star – s- closed biset.

Proof

Let A_B and F_B be G – star – s- closed biset in X_B .

Let U_B be GS-open biset in X_B , such that $A_B \cup F_B \subseteq U_B$.

$A_B \subseteq U_B$ and $F_B \subseteq U_B$.

Since A_B and F_B are G – star – s- closed biset such that $scl(A_B) \subseteq U_B$ $scl(F_B) \subseteq U_B$

Hence $scl(A_B \cup F_B) = scl(A_B) \cup scl(F_B) \subseteq U_B$

Therefore $A_B \cup F_B$ is G – star – s – CB .

Results 4.5

- I. Every G – star – s- closed biset is GS- closed but not conversely.
- II. Every G – star – s- closed biset in X_B is a SG- closed biset in X_B but not conversely.

Theorem 4.6

A subbisets A_B of X_B G – star – s- closed biset in X_B iff $scl(A_B) - A_B$ contains no empty Gs – closed biset in X_B .

Proof

Suppose that G_B is non –empty GS- closed subbisets of $scl(A_B) - A_B$. Now $G_B \subseteq scl(A_B) - A_B$.

Then $G_B \subseteq scl(A_B) \cap \overline{A_B}$.





Therefore $G_B \subseteq scl(A_B)$ and

$$G_B \subseteq \overline{A_B}$$

Since $\overline{G_B}$ is a Gs-open biset, $scl(A_B) \subseteq \overline{G_B}$.

A_B is G-star-s- closed biset,

$$scl(A_B) \subseteq \overline{G_B}$$

That is, $G_B \subseteq scl(\overline{A_B})$

Since $\overline{G_B}$ is Gs-open biset and A_B is G-star-s- closed biset,

$$scl(A_B) \subseteq \overline{G_B}$$

$$G_B \subseteq scl(\overline{A_B})$$

$$G_B \subseteq scl(A_B) \cap [scl(\overline{A_B})] = \emptyset$$

$$G_B = \emptyset$$

Therefore, $scl(A_B) - A_B$ contains no non empty Gs-closed biset.

Conversely, let $scl(A_B) - A_B$ contains no non empty Gs-closed biset.

Let $A_B \subseteq U_B$, U_B is Gs-open biset.

Suppose that $scl(A_B)$ is not contained in U_B . then $scl(A_B) \cap \overline{U_B}$ is a non- empty Gs – closed biset and contained in $scl(A_B) - A_B$ which is contradiction by our assumption.

Therefore, $scl(A_B) \subseteq U_B$ and A_B is G-star-s-closed biset.

Proposition 4.7

Let (X_B, τ) be a compact topological bispace. If A_B is G-star-s-closed subbisets of X_B , then A_B is compact.

Proof

Let $\{U'_B\}$ be an open biset cover of A_B . Since every open biset is Gs-open and A_B is G-star-s-closed biset, we get $scl(A_B) \subseteq \cup \{U'_B\}$

Since a closed subbisets of a compact bispace is compact, now $scl(A_B)$ is compact.

Therefore, there exists a finite sub open bicover say $\{U'_B \cup U_B^2 \cup \dots U_n\}$ of $\{U'_B\}$ for $scl(A_B)$.

So, $A_B \subseteq scl(A_B) \subseteq U'_B \cup U_B^2 \cup \dots U_n$.

Therefore A_B is compact.

Definition 4.8

A subbisets A_B of topological bispace X_B is called G-star-s-open biset. If $\overline{A_B}$ is G-star-s-closed. The class of all G-star-s-closed biset is denoted by G-star-s-OB(X_B, τ).

5 Generalized pre- open sets in (X_B, τ) .

In this section, Generalized pre-open bisets [briefly, GPOB], GPOB-compact notion is introduced and connections to other several well- known types of compactness are discussed.

Definition 5.1

A bispace (X_B, τ) is GPOB-compact if every GPOB- cover of X_B has finite sub cover, whenever a cover consisting of GPO- bisets.

Results 5.2

Every openbisets is GPO- biset.

If (X_B, τ) is GPOB- compact bispace, then it is compact.

Definition 5.3

A bispace is strongly irresolvable if and only if every pre-open biset is semi-open bisets.

Definition 5.4

Let (X_B, τ) be a bispace is said to be \mathbb{P} – closed biset[respectively, quasi \mathbb{H} – closed biset (simply, qHCB)] if every pre-open biset (respectively, open biset) cover of X_B has finite subfamily the pre closures (resp., closures) of whose member cover X .

A topological bispace (X_B, τ) is said to be strongly compact biset if every pre-open bicover of X_B has a finite sub cover.

Definition 5.5

A bispace (X_B, τ) is called s- closed biset if every semi-open biset cover has a finite subfamily the semi-closures of whose members cover X_B .

Result 5.6

A subbisets $A_B \subseteq X_B$ is open biset if and only if A_B is a GPOB and a pre -open biset.



**Theorem 5.7**

If a bispace (X_B, τ) is GPOB – irresolvable and GPOB – compact, then it is \mathbb{P} – closed biset.

Proof

Let $A_B = \{A_B^\alpha; \alpha \in \Delta\}$ be a pre – open bicover of X_B since X_B is GPOB – irresolvable, A_B^α is a GPOB for all $\alpha \in \Delta$ and A_B is a GPOB – cover of X_B .

Since X_B is GPOB – compact, it has a finite subcover.

Thus, $X_B \subseteq \bigcup_{i=1}^n A_B^{\alpha_i}$.

But, $\bigcup_{i=1}^n A_B^{\alpha_i} \subseteq \bigcup_{i=1}^n \text{pcl}(A_B^{\alpha_i})$. (resp., pcl – preclosed biset) and so X_B is \mathbb{P} – closed.

Since a GPOB need not to be preopen, a \mathbb{P} – closed bispace need not be GPOB – irresolvable or GPOB – compact.

6 Applications of semi – open Bisets

The union of all semi – open bisets of X_B contained in F_B is called the semi – interior of biset F_B and it is denoted by $sInt(F_B)$.

The intersection of all semi – closed bisets containing F_B is called the semi – closure of F_B and it is denoted by $sCl(F_B)$. $sCl(F_B) - sInt(F_B)$ is called the semi – frontier of F_B and is denoted by $sFr(F_B)$. $sInt(X_B - F_B)$ is said to be the semi – exterior of F_B and is denoted by $sExt(X_B - F_B)$.

In this paper, these notions are further investigated. We also introduce and study the concepts of semi – isolated points and semi – scattered bispaces.

Theorem 6.1

For a bisets $F_B \subset X_B$, the following are equivalent

- F_B is dense in X_B .
- $sCl(F_B) = X_B$
- If G_B is any semi – closed sub biset of A_B and $F_B \subset G_B$, $G_B = X_B$.
- For each $a_B \in X_B$, every semi – open biset containing a_B has non- empty intersection with F_B .
- $sInt(X_B - F_B) = \emptyset$.

Proof (a) \Rightarrow (b)

Let U_B be an open biset with $U_B \subset G_B \subset cl(U_B)$

Since $U_B \subset X_B - F_B$ and F_B is dense, therefore $U_B = \emptyset$ and so $cl(U_B) = \emptyset$.

Hence $G_B = X_B$. It follows that the intersection of all semi – closed bisets containing F_B is X_B .

That is $sCl(F_B) = X_B$.

(b) \Rightarrow (a)

Let $sCl(F_B) = X_B$

Now, a subset F_B of a topological bispace X_B such that every points of X_B either belong to F_B or else is arbitrary close to a member of F_B

That is, $sCl(F_B) \subset Cl(F_B)$ for every $F_B \subset X_B$.

Therefore F_B is dense in A_B .

(b) \Rightarrow (c) and (c) \Rightarrow (d) are obvious . (d) \Rightarrow (e).

If $sInt(X_B - F_B) \neq \emptyset$,

Then $sInt(X_B - F_B)$ is a non – empty semi – open biset. However, $(X_B - F_B) \cap F_B = \emptyset$ since $sInt(X_B - F_B) \subset X_B - F_B$, we have $sInt(X_B - F_B) \cap F_B = \emptyset$

This contradicts (d), and means $sInt(X_B - F_B) = \emptyset$.

(e) \Rightarrow (b) let $sInt(X_B - F_B) = \emptyset$ and since $sInt(X_B - F_B) = X_B - sCl(F_B)$ therefore, $sCl(F_B) = X_B$.

Theorem 6.2

Let F_B be a subbisets of the bispace X_B then

- $sFr(sInt(X_B - F_B)) \subset sFr(F_B)$
- $sFr(scl(X_B - F_B)) \subset sFr(F_B)$
- $sExt(X_B) = \emptyset$
- $sExt(\emptyset) = X_B$
- $sExt(F_B) = sExt[X_B - sExt(F_B)]$
- $sInt(F_B) = F_B - sFr(F_B)$
- $sInt(F_B) \subset sExt[sExt(F_B)]$





$$h) \quad X_B = S \text{Int}(F_B) \cup S \text{Ext}(F_B) \cup s F_r(F_B)$$

Proof

Only the proof of (e) will be given here, we have,

$$\begin{aligned} & S \text{Ext}[X_B - S \text{Ext}(F_B)] \\ &= S \text{Ext}[X_B - S \text{Int}(X_B - F_B)] \\ &= S \text{Int}[X_B - (X_B - (X_B - S \text{Int}(X_B - F_B)))] \\ &= S \text{Int}[S \text{Int}(X_B - F_B)] \\ &= S \text{Int}(X_B - F_B) \\ &= S \text{Ext}(F_B) \end{aligned}$$

Theorem 6.3

If $F_B, G_B \subset X_B$ such that $s F_r(F_B) \cap s F_r(G_B) = \emptyset$ and $F_r(F_B) \cap s F_r(G_B) = \emptyset$, then $S \text{Int}(F_B) \cup S \text{Int}(G_B) = S \text{Int}(F_B \cup G_B)$.

Proof

Let $a_B \in S \text{Int}(F_B \cup G_B)$. Then there exists a semi open bisets U_B such that $a_B \in U_B \subset F_B \cup G_B$. If $a_B \in s F_r(F_B)$ then $a_B \notin F_r(G_B)$. So there exists an open biset V_B containing a_B with $V_B \subset G_B$ or $V_B \subset X_B - G_B$.

Assume $V_B \subset G_B$ then

$$a_B \in U_B \cap V_B \subset G_B.$$

Since, $U_B \cap V_B$ is semi – open biset $a_B \in S \text{Int}(G_B)$.

On the other hands, if $V_B \subset X_B - G_B$, then $a_B \in U_B \cap V_B \subset F_B$ and so

$$a_B \in S \text{Int}(F_B).$$

if $a_B \notin S \text{Int}(G_B)$. In particular, suppose that $a_B \notin S \text{Cl}(F_B)$ for otherwise $a_B \in S \text{Int}(F_B)$. Then $a_B \in G_B \subset S \text{Cl}(G_B)$ since $a_B \in F_B \cap G_B$. We assume that $a_B \notin F_r(G_B)$ for otherwise $a_B \in S \text{Int}(G_B)$. Thus $a_B \notin F_r(F_B)$ and the argument now proceeds similarly in the case when $a_B \notin F_r(G_B)$.

Theorem 6.4

A biset $F_B \subset X_B$ is nowhere dense iff $\text{Int}(S \text{cl}(F_B)) = \emptyset$.

Proof

The proof is obvious

Since $\text{Int}(\text{cl}(F_B)) = \text{Int}(S \text{cl}(F_B))$ for every $F_B \subset X_B$.

Definition 6.5

Let F_B be a subbisets of a topological bispace X_B . then,

a) A point $a_B \in F_B$ is said to be a semi- isolated point of F_B if there is a semi- open biset U_B such that $U_B \cap F_B = \{a_B\}$.

b) A biset F_B is said to be semi – discrete if each point of F_B is semi- isolated.

c) A bispace (X_B, τ) is said to be semi- scattered if every non – empty subset of X_B has a semi – isolated point.

It is obvious that every isolated point of $F_B \subset X_B$ is semi- isolated. But the converse is not true as can be seen from the following example

Example 6.6

Consider the usual topology on \mathbb{R} .

Let $F_B = [0,1] \cup [1,2]$, A subbisets $U_B = [1,2) \cup [2,3]$ of \mathbb{R} is semi – open biset and $U_B \cap F_B = \{1\} \cup \{2\}$, $1,2 \in F_B$ is a semi – isolated point of F_B but it is not isolated point of F_B .

Remarks 6.7

Let (X_B, τ) be a topological bispace and $F_B \subset X_B$. Then

a) A semi- isolated point of X_B is merely an isolated point. For $\{a_B\}$ is semi – open bisets iff $\{a_B\}$ is open biset. The biset of all isolated (semi- isolated) points of a biset $F_B \subset X_B$ is denoted by $F_B^s(F_B^{ss})$.

b) A bispace X_B is a semi – discrete subset of a biset of itself iff X_B is discrete. Every discrete biset is semi – discrete. But the converse need not be true as can be seen from the following example.

Example 6.8

The subset of biset $X_B = [0,1] \times \{0\} \cup [1,2] \times \{1\} \subset \mathbb{R}^2$ is dense – in – itself but it is semi – discrete. For each $X_B = (r, 0) \cup (s, 1) \in F_B$. Let $U_B(X_B)$ be the open biset unit disk with non – negative center coordinates which is tangent to F_B at the point x_B .





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Thus $G_B = U_B \cap \{x_B\}$ is semi – open biset and $\{x_B\} = G_B \cap F_B$. This shows that each point $x_B \in F_B$ is a semi – isolated point of F_B .

This implies that F_B is semi – discrete in R^2 . However F_B is not discrete since its points are not isolated.

If F_B^s denotes the semi- derived biset of F_B , then we have the following theorem

Theorem 6.9

If F_B is a subset of biset of a bispase X_B , then

- a) $F_B^{s1} \cap F_B^{ss} = \emptyset$
- b) $scl(F_B) = F_B^{s1} \cap F_B^{ss}$
- c) $X_B = F_B^{s1} \cap F_B^{ss} \cup Ext(F_B)$

Proof

- (a) $a_B \in F_B^{ss} \Leftrightarrow$ there is a semi – open biset U_B containing a_B such that

$$U_B \cap F_B = \{a_B\}$$

$$\Leftrightarrow U_B \cap (F_B - \{a_B\}) = \emptyset$$

$$\Leftrightarrow a_B \notin F_B^{s1}.$$

- (b) $a_B \in scl(F_B) \Leftrightarrow U_B \cap F_B = \emptyset$ for every semi – open biset U_B containing a_B

$$U_B \cap (F_B - \{a_B\}) \neq \emptyset \text{ if } a_B \notin F_B.$$

$$U_B \cap (F_B - \{a_B\}) = \emptyset \text{ if } a_B \in F_B.$$

$$\Leftrightarrow a_B \in F_B^{s1} \text{ or } a_B \in F_B^{ss}.$$

$$\Leftrightarrow a_B \in F_B^{s1} \cup F_B^{ss}$$

- (c) obvious in view of parts (a)&(b)

Theorem 6.10

If $F_B \subset X_B$ is dense, then the following hold.

- a) The semi – isolated points of F_B are precisely the isolated points of F_B as a subbispase.
- b) $F_B \subset F_B^{s1}$ iff $F_B^s = \emptyset$.

Proof

- (a) If $\{a_B\} = G_B \cap F_B$ where G_B is semi open biset, then there is an open biset U_B such that $U_B \subset G_B \subset cl(U_B)$

$U_B \cap F_B \neq \emptyset$ implies $U_B \neq \emptyset$ since F_B is dense in A_B . $G_B \neq \emptyset$ implies $U_B \neq \emptyset$.

Thus $U_B \cap F_B = \{a_B\}$ and a_B is an isolated points of the subbispase F_B . converse is obvious.

- (b) $F_B^s = F_B^{ss}$ because F_B is dense in A_B . Since $A_B = scl(F_B)$

$$= F_B^{s1} \cup F_B^{ss}$$

$$= F_B^{s1} \cup F_B^s$$

$$\text{And } F_B^{s1} \cup F_B^{ss} = \emptyset$$

$$F_B = F_B^s \cup (F_B \cap (F_B^{s1}))$$

$$\text{Thus, } F_B \subset F_B^{s1} \text{ iff } F_B^s = \emptyset.$$

CONCLUSION

The classes of pre-open and pre-closed bisets are defined using semi-open and semi-closed bisets in topological bispase. G-star-s-closed bisets, GPOB, GPOB-compact bisets are derived a new decomposition of closure and interior. This idea can be extended to various spaces.

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RESEARCH ARTICLE

Employee Experience and the Digital Shift: A Deep Dive into India's IT Sector HR Transformation

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ABSTRACT

This study delves into the transformative effects of digitalization on human resource management within India's information technology (IT) sector, a pivotal industry for the country's economic growth. The present study concentrates on three major independent variables: administrative functions, employee engagement, and work-life equilibrium. Administrative functions encompass tasks such as managing employee records, updating information, and handling benefits. Employee engagement is characterized by the cultural, technological, and physical dimensions of the work environment, whereas work-life equilibrium pertains to personal relationships, mental and physical health, and overall contentment. Data was compiled from a pool of 114 participants working in the IT sector in Chennai, India. A thorough approach utilizing Structural Equation Modeling (SEM) was employed, using the Smart PLS software tool. This tool enabled evaluation of model fit, composite reliability of measures, and distinctness of constructs or discriminant validity. Testing hypotheses of study, Partial Least Squares (PLS) path modelling was utilized, delivering robust and reliable interpretations of collected data. Findings from investigation indicated positive association between employee engagement and process of digital transformation within realm of HR. However, study did not identify similar positive relationship for variables of administrative tasks and work-life equilibrium. This insinuates that while enhanced employee experience can drive HR digital transformation, traditional administrative tasks and work-life balance efforts may not exert similar influence. Insights bear significant implications for organizational decision-making, underscoring need for strategizing actions towards enhancing digital transformation in human resource processes.





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Keywords: Digital transformation, Human resource management, Employee experience, Work-family balance, India's IT sector

INTRODUCTION

The digital reshaping of human resources (HR) carries immense weight within the information technology (IT) sphere, particularly when viewed through lens of an employee's experience. As the drivers of innovative leaps and providers of digital services to various industries, IT companies are shaping a new business environment where digital technology plays an increasingly vital role. The success of an organization hinges significantly on its HR, which, by driving productivity and profitability, aids in realizing the organization's vision and mission. In this context, digital technology is significantly influencing areas such as the work-life balance of employees, the work environment, and HR administrative functions. This manuscript endeavours to explore the perceptions of employees regarding the digital metamorphosis of HR in the IT industry, with a specific focus on Chennai, India. This region is selected owing to its dense aggregation of IT service firms. The digital age's advent began earnestly around 2005, escalating from the early 1980s when less than 1% of stored information was in digital format, to an astounding 99% in 2014. The increase in data stored digitally has seen an explosive growth, rising from 2.5 exabytes in 1986 to five Zetta bytes in 2014 (Clement, 2020). Alongside this, internet usage linked with digital cloud storage reached 59% of the world population (4.54 billion users) in 2021, while hand phone subscribers linked to digital storing amounted to 62% of the world population (4.78 billion users). India's IT sector, a significant contributor to the country's GDP with a 7.7% share and total revenue of US\$160 billion in 2017 (Singh, 2017), primarily comprises business process outsourcing and IT services (Nirmal, 2017). Chennai, renowned as Asia's largest IT park and home to a majority of India's software companies (Parayil, 2016), is the country's second-largest exporter of business process outsourcing and IT services. The journey of HR digital transformation can be segmented into three phases: digitization, digitalization, and digital transformation. Initially, analog signals were converted to bits in a process known as scanning, which allowed information storage in different systems and mediums (Parviainen, Tihinen, Kääriäinen, & Teppola, 2017).

This marked the era of digitization. Gradually, digitization evolved into digitalization, regarded as the fourth industrial revolution, with profound influences on human activity domains, including manufacturing processes, communication patterns, transportation systems, and working styles. Lamberton and Stephen (2016) argue that the final phase, digital transformation, requires harnessing the power of technological innovation to build or adapt current business procedures, cultural norms, and customer anticipations in response to changing market and business needs. This transformation has gained attention across all business operations, leading to significant changes in business processes and developments (Nambisan S, Wright M, 2019). Verhoef et al. (2017) posited that digital transformation involves the incorporation of multiple digital tools such as social media platforms, cloud computing, mobile technology, and analytics into business activities, which in turn fosters innovation and stimulates dynamic interactions with consumers through social media channels. Historically, HR was viewed as an administrative function responsible for employee services. However, modern HR is now at the forefront of leading global organizations through digital transformation John Bersin, Tiffany McDowell, Amir Rahnema (2017), and Michael Stephan, David Brown (2017) highlighted that digital transformation is experiencing rapid and significant alterations, especially in relation to the digital workforce, digital workplace, and digital HR. Delving into employees' viewpoint on HR digital transformation in India's IT sector, this research aims to verify three hypotheses: 1) administrative tasks constructively impact HR digital transformation, 2) positive influence on HR digital transformation is exerted by employee experiences, and 3) a harmonious correlation subsists between work-family balance and HR digital transformation. The underlying structure of this investigation is shaped by past scholarly pursuits, involving diverse definitions, available data, and previous studies centered on digital transformation. This layout aims to underscore the employee perspective by presenting a detailed analysis and interpretation of the results. Conclusively, it derives an understanding and provides a direction for further inquiry in this field.



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Figure 1 visually presents our research model, integrating three standalone variables: administrative tasks (personnel records, detail updates, benefits data), employee experience (cultural, technological, physical environments), and work-family balance (personal relationships, physical and mental wellness, general satisfaction). Each of these variables feeds into HR digital transformation, identified as our dependent variable. Our research schematic demonstrates a direct link between independent elements and our dependent variable, thereby illustrating potential influences exerted by these individual factors. Overall, this exploration probes deeply into impacts that digital transformation might wield on HR within IT sector domains, chiefly from an employee's standpoint. It is a vital exploration of the modern workplace where HR is no longer a passive administrative function but a proactive driver of organizational change. Through this study, we hope to contribute valuable insights to the ongoing discourse on the digitalization of human resources within the rapidly evolving IT sector in India.

Review of Scholarly Literature and Formulation of Hypotheses

Scholarly literature on digital transformation in human resources provides a holistic understanding, amalgamating insights from multiple disciplines, thus facilitating informed decision-making for progressive regulatory changes in organizations (Tarafdar & Davison, 2018). Digitization, an initial stage of this transformation, entails documentation of the organization's internal and external activities without direct engagement in value creation. The subsequent stage, digitalization, involves leveraging digital technologies for optimizing business operations and cost savings (Pagani & Pardo, 2017). The full-fledged human resource digital transformation phase capitalizes on these digital technologies to hone core competencies and navigate challenges (Singh & Hess, 2017). Digital transformation enhances administrative task efficiency in human resources, playing a crucial strategic role in organizations (Silva & Lima, 2018). This metamorphosis complements conventional human resource management practices, facilitating a digital approach towards administrative tasks. It often poses challenges for organizations resistant to change. However, proficient information system management can guide human resource managers through digital transformation processes (Hausberg, Liere-Netheler, Packmohr, Pakura, & Vogelsang, 2019). For human capital evolution to transpire, a forward-thinking mindset is crucial for managers. Digital transformation in human resources provides a platform for skill development, easing work procedures and expanding employee capabilities (Betchoo, 2016). By amalgamating traditional administrative procedures with employee development aspects, digital transformation facilitates a streamlined approach to organizational human resource management. Fenech, Baguant, and Ivanov (2019) posit that technology can be leveraged to reduce administrative workload and enhance job design, leading to our first hypothesis:

H1: Administrative tasks within the Indian IT sector positively influence human resource digital transformation.

Digital transformation promotes streamlined work processes, enhanced work quality, and modern operational approaches within organizations. Integrating digital technologies like teleconferencing, robotic process automation, wearable tech, and computerized monitoring systems cultivates superior work environments and bolsters employee experiences (Cascio & Montealegre, 2016). Thus, a technological environment within an organization can significantly contribute to enhancing employee experiences. This influence and multidimensional support in the workplace lead to our second hypothesis:

H2: Employee experience positively impacts human resource digital transformation within the IT sector in India.

Balancing work and personal life is a significant concern for modern organizations, affecting personal relationships amongst employees and their families (Albalushi & Sankar, 2019). Implementing digital transformation can mitigate conflicts between professional commitments and personal responsibilities, promoting overall employee well-being. Digital transformation supports workload management, enhancing both physical and mental health (Vineetha Prakash, 2018). Further, flexible work schedules, aided by digital transformation, contribute to work-family balance and employee happiness (Sankar, 2018). Consequently, organizations need to implement digitally transformed human resource practices to ensure a balanced personal-professional life for their employees, leading to our third hypothesis:



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H3: Work-family balance within the IT sector in India is positively influenced by human resource digital transformation. Digital transformation within human resource management has begun to attract substantial attention in recent years. At first glance, the core of digital transformation within human resources entails harnessing digital technologies to minimize mundane administrative tasks, enabling HR professionals to devote more time to strategic initiatives (Kumar & Shankar, 2019). Yet, it extends beyond simple task automation to influence a broad array of HR functions - spanning talent acquisition, employee development, performance management, and succession planning, as noted by Parviainen, Tihinen, Kääriäinen, and Teppola in 2017. Human resource digital transformation also fosters a conducive environment for the effective delivery of employee services. By leveraging digital tools and solutions, HR professionals can now address the diverse needs and expectations of a multigenerational workforce, leading to increased employee satisfaction and engagement (Ghoshal S, 2015). This digital pivot can also help organizations build a resilient and adaptive workforce that can quickly respond to dynamic business needs. However, it's crucial to note that digital transformation is not an end, but a means to achieve strategic HR goals. It's a change process that necessitates a shift in mindset, culture, and operations (Scott, C.

R., & Lewis, 2017). In this context, HR leaders play a pivotal role in driving this change, right from envisioning the digital strategy to managing the transformation process. Looking ahead, understanding the impact of digital transformation on work-family balance becomes essential. With an ever-increasing emphasis on flexibility and work-life balance, digital technologies offer immense possibilities, including flexible work arrangements, telecommuting, and virtual collaboration. By enabling employees to balance their professional commitments and personal life effectively, digital transformation can significantly improve their overall well-being and productivity (Alaradi&Sankar, 2019). However, the transformative journey towards digital HR is fraught with challenges. These include resistance to change, data privacy concerns, and the risk of technology obsolescence. Overcoming these challenges requires a strategic approach, robust change management processes, and continuous learning and development initiatives. As we delve into this exploration, it is evident that a digital-first approach to HR can redefine the future of work and employee experience, making it a strategic priority for organizations today. Consequently, this research intends to illuminate the intricate link between digital transformation in human resources and its effects on administrative tasks, the employee experience, and work-family equilibrium in India's IT sector, offering a distinctive viewpoint on this burgeoning area of study. Moreover, the role of digital transformation in refining the administrative tasks in HR cannot be underestimated. With advancements in artificial intelligence, machine learning, and cloud computing, the HR domain has started embracing a more data-driven approach.

Administrative tasks such as maintaining personnel records, benefits management, and employee onboarding that once consumed significant time and resources can now be performed with precision and efficiency (Hausberg, Liere-Netheler, Packmohr, Pakura, & Vogelsang, 2019). By automating these routine activities, HR professionals can contribute more strategically towards achieving organizational goals. On a larger canvas, digital transformation significantly enhances the overall employee experience. Technologies such as teleconferencing, advanced analytics, AI-based personal assistants, and virtual reality are increasingly shaping the way employees interact with their organizations (Larkin, 2017). This enhances not only their work proficiency but also facilitates the development of a work culture that fosters innovation, engagement, and continuous learning. Beyond the organizational boundaries, the impact of digital transformation extends to how employees balance their work and family life. In an era where work-life balance is a crucial factor in talent attraction and retention, the role of technology in enabling flexible work schedules, remote working options, and efficient time management is pivotal (Sankar, 2018). The use of digital tools can provide employees the autonomy to manage their work schedules effectively, which in turn, improves their physical health, mental well-being, and overall happiness. Hence, this research seeks to methodically examine the beneficial impact of administrative tasks, worker experiences, and work-life harmony on digital transformation in HR, specifically within India's IT industry. The proposed conjectures for this investigation are as follows:

H1: Human resource digital transformation within the IT sector in India is positively influenced by efficient administrative tasks.



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H2: An enhanced employee experience exerts a positive influence on HR digital transformation in the Indian IT sector.

H3: An effective work-family balance contributes positively to the digital transformation of HR within India's IT sector. These hypotheses will guide the research to provide meaningful insights into how digital transformation is reshaping HR practices within the IT sector in India, fostering a new paradigm of work culture and employee engagement.

METHODOLOGY

Participants for this study were sourced from various IT companies in Chennai, encompassing different job roles, including middle-level managers, staff, and administrative personnel. This participant pool ensured varied responses and broad representation (Cooper, D. R., Schindler, P. S., & Sun, 2006). Online surveys and personal interviews facilitated nuanced understanding of employee perceptions on HR digital transformation. MCAR (Missing Completely at Random) test using SPSS software checked missing data randomness, yielding ($\chi^2=45.827$, $df=97$, $sig.=1.000$) and leading to null hypothesis rejection. An A-priori sample size calculator (Soper, 2020) determined appropriate sample size for Structural Equation Modeling (SEM), considering effect sizes (Cohen's d of 0.5), 95% statistical power level, and 0.05 probability level. This process recommended a sample size between 106 and 212 for all effect sizes. A sample size of 114 was thus chosen, exceeding minimum requirements. Detailed analysis followed data collection. PLS and ADANCO 1.1 software tested discriminant validity, and SPSS software assessed instrument reliability. Next, Smart PLS 3.3.2 software scrutinized measurement and structural models. This dual-stage analysis meticulously examined if administrative tasks, employee experiences, and work-family balance positively influenced HR digital transformation in IT sector of India.

RESULTS

Before analyzing measurement and structural models, an evaluation of model fit took place. This crucial step reports on model fit, utilizing inferential statistics or fit indices. Above table presents model fit measures such as standardized root mean square residual (SRMR), evaluated using ADANCO software (Dijkstra & Henseler, 2015). Additional model fit indicators like unweighted least squares discrepancy (dULS) and geodesic discrepancy (dG) were determined through bootstrap method (Hair, Hollingsworth, Randolph, & Chong, 2017). A cautious perspective recommends an SRMR value under 0.1 as an indicator of good fit; a calculated outcome of 0.097 confirms model fit for this instance. For dG and dULS values, outcomes under 95th percentile of bootstrap quantile typically align with traditional views. Given calculated dG and dULS values of 1.49 and 0.52 respectively, it becomes clear that our model fulfils these fit requirements, reinforcing model fit. Table 2, located below, presents calculated values for composite reliability, Cronbach's alpha, and average variance extracted (AVE=convergent validity), crucial for assessing measurement model. Assessment of measurement model involved considering factors such as Cronbach's alpha, composite reliability, AVE (convergent validity), outer loadings, and discriminant validity. As illustrated in table above, values computed for composite reliability surpassed critical cut-off point of 0.7 (Henseler, Hubona, & Ray, 2016), thus establishing their validity. Additionally, overall value for reliability statistics computed through SPSS hit 0.870, demonstrating satisfactory internal consistency. Values of average variance extracted (AVE), indicative of convergent validity, went beyond necessary cut-off of 0.50, further endorsing suitability and validity of model. Discriminant validity underwent an assessment via PLS approach, as depicted in Table 3. Employment of Fornell-Larcker criterion, a common measure to evaluate degree of shared variance among latent variables of model, was witnessed. Monotrait-Hetero method correlations, when under 0.9, are regarded as acceptable (Dijkstra & Henseler, 2015). As observed in Table 3, all calculated values fall below the threshold for Monotrait-Heteromethod correlations, indicating the acceptance of discriminant validity. These findings support the notion that the utilized measurement scales are both reliable and valid.





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Structural Equation Modeling (SEM)

Figure 2 shows derived equation's R² value as 0.969, signifying statistical significance at 1% probability level. It suggests that administrative tasks, employee experience, and work-family balance explain 96.9% variation in human resource digital transformation. Following Table 4 details an in-depth examination of structural relationships using PLS Algorithm. It also includes an assessment for presence of multi collinearity using Variance Inflation Factors (VIF) and tolerance parameters. Results make it evident that variables do not showcase multicollinearity. Hair Jr, Black, Babin, & Anderson (2010) propose a VIF value exceeding 4.0 or below 0.2 signals issues of multicollinearity. In this model, however, VIF values span from 1.353 (Overall Happiness) to 2.020 (Technological Environment), fitting comfortably within an acceptable range and affirming lack of multicollinearity. Table 5, found below, delivers comprehensive results from hypothesis testing using a bootstrapping technique. Bootstrapping, with 5000 re sampling procedures within Smart PLS, facilitates establishment of significance level of paths among variables.

Discoveries imply that administrative tasks fail to exert a positive influence on human resource digital transformation ($\beta=-0.011$, $t\text{-value}=0.841$, $p>0.05$), leading to rejection of Hypothesis 1 (H1). This observation coincides with challenges encountered by numerous HR departments as they navigate transition from traditional administrative responsibilities (McGrath, 2019). Contrastingly, data endorses Hypothesis 2 (H2), illustrating that employee experience positively impacts human resource digital transformation ($\beta=0.957$, $t\text{-value}=32.504$, $p<0.05$). Technological support in forms of teleconferencing, robotics, wearable computing devices, and automated monitoring systems can enhance work environments and uplift employee experiences, thereby bolstering digital transformation in HR (Cascio & Montealegre, 2016). Lastly, Hypothesis 3 (H3) lacks support, denoting that work-family balance fails to significantly influence human resource digital transformation ($\beta=0.028$, $t\text{-value}=0.870$, $p>0.05$). This outcome may emanate from increasingly indistinct boundaries between personal and professional life in today's work settings, causing work-family balance strategies to vary across generations (Simer, 2019). Hence, HR digital transformation may not intrinsically promote work-family balance.

CONCLUSION

This investigation embarked on an assessment of influence from administrative tasks, employee experience, and work-family balance on human resource digital transformation within IT organizations located in Chennai. A Structural Equation Model was deployed for an all-encompassing data analysis. Insights yielded from our findings carry significant weight in understanding human resource digital transformation, illuminating focal areas for organizations. Results implied that amongst three independent variables studied, only employee experience had a notable influence on human resource digital transformation. This stresses vital importance of employees' experiences in shaping successful digital transformation execution within human resource framework. Technological support such as teleconferencing, automated monitoring systems, and other advancements turn out key to enhancing employee experience, thus positively swaying digital transformation. In contrast, no substantial influence of administrative tasks and work-family balance on HR digital transformation was discerned from this study. This implies that the traditional role of HR in handling administrative tasks doesn't necessarily translate into effective digital transformation. Similarly, the work-family balance parameter, despite its importance in employee well-being, showed no notable contribution to digital transformation in HR practices. These results suggest that organizations must prioritize enhancing employee experience through strategic digital implementations to achieve successful digital transformation in human resource practices. While administrative tasks and work-family balance remain critical areas of HR, these elements alone may not drive the digital transformation process. The IT organizations in Chennai, and possibly beyond, can benefit from these insights to improve their HR digital transformation strategies. In the future, research might explore other variables that potentially impact human resource digital transformation. Furthermore, this study can be expanded to other geographical locations or industries for more comprehensive insights. Digital transformation in HR is an ongoing journey, and understanding its dynamics will remain crucial as organizations continue to navigate the digital age.





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Scope for Further Research

Insights gleaned from this study pave way for numerous avenues warranting further research. Analysis in this investigation concentrated on IT organizations in Chennai. Nevertheless, expanding such research to incorporate a wider demographic, inclusive of varied geographical regions and industries, might yield generalized and more holistic insights. While this investigation emphasized administrative tasks, employee experience, and work-family balance as predictors of HR digital transformation, upcoming research could delve into other potential variables. This could encompass an exploration of roles played by organizational culture, leadership support, digital literacy level among employees, and technology infrastructure investments in successful HR digital transformation. Notably, a significant role was detected in digital transformation played by employee experience, demanding deeper exploration in this area. Future studies might focus on particular aspects of employee experience that strongly impact digital transformation. For instance, studying influences of flexible working options, digital training and development programs, or digital communication tools on HR digital transformation could prove insightful. Additional research might also concentrate on barriers to HR digital transformation, such as employee resistance to change, digital skills deficiency, or insufficient resources. Comprehending these obstacles will aid organizations in strategizing to overcome them. Finally, a longitudinal study tracking HR digital transformation over time would offer significant utility. Such a study could provide insights into long-term effects of digital transformation on HR practices, employee productivity, and overarching organizational performance. These represent merely a fraction of areas where future research could extend findings of this study, enhancing our understanding of intricate interplay between HR practices and digital transformation.

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Table 1: Goodness of Model Fit

Fit Criteria	Value
SRMR	0.097
dULS	0.52
dG	1.49

Table 2: Composite Reliability

Criterion	Administrative Tasks	Employee Experience	Work-family Balance	Human Resource Digital Transformation
Cronbach's Alpha (α)	0.745	0.805	0.755	0.790
Composite Reliability (CR)	0.775	0.885	0.860	0.860
Average Variance Extracted (AVE)	0.555	0.720	0.670	0.550

Table 3: Discriminant Validity

Criterion	Administrative Tasks (AT)	Employee Experience (EE)	Human Resource Digital Transformation (HRDT)	Work-family Balance (WFB)
AT	0.745			
EE	0.120	0.850		
HRDT	0.130	0.890	0.745	
WFB	0.145	0.830	0.820	0.825

Table 4:

Variable Relationships	Beta	SE	P-Values	VIF
Benefit Information ? Administrative Tasks	0.903	0.327	0.035	1.429
Personal Records ? Administrative Tasks	0.411	0.480	0.732	1.434
Updating Details ? Administrative Tasks	0.816	0.295	0.066	1.608
Cultural Environment ? Employee Experience	0.813	0.010	0.000	1.693
Physical Environment ? Employee Experience	0.835	0.011	0.000	1.641
Technological Environment ? Employee Experience	0.889	0.012	0.000	2.020
Personal Relationship ? Work-family Balance	0.856	0.015	0.000	1.660
Personal, Mental Health ? Work-family Balance	0.888	0.010	0.000	1.934
Overall Happiness ? Work-family Balance	0.693	0.014	0.000	1.353

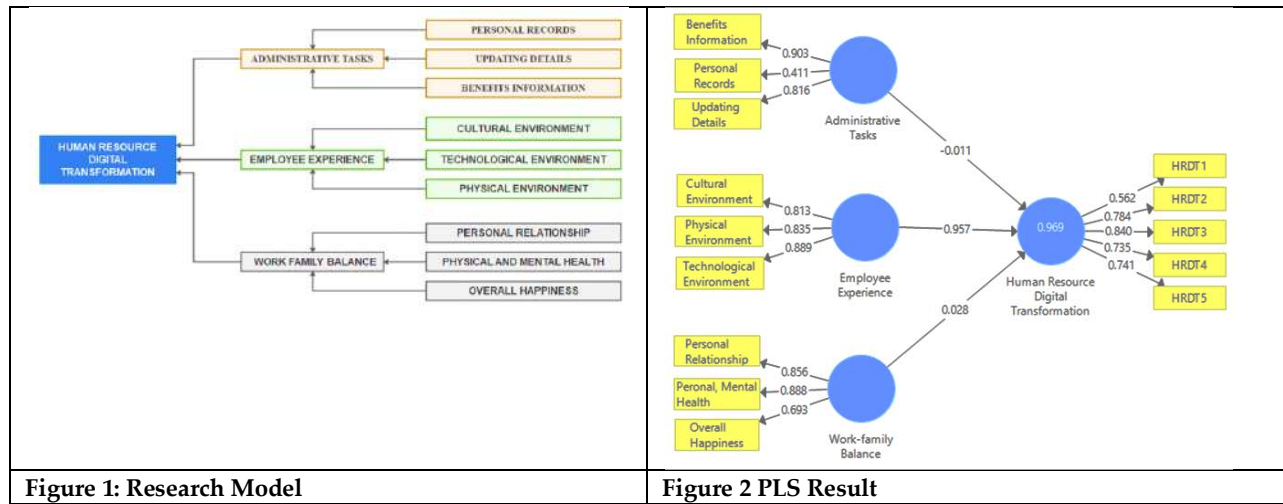
Table 5 Hypothesis Testing

Hypotheses	Beta	t-Statistics	P-Values	Outcome
Administrative Tasks → HRDT	-0.012	0.840	0.402	Not Supported
Employee Experience → HRDT	0.958	32.500	0.000	Supported
Work-family Balance → HRDT	0.029	0.880	0.386	Not Supported





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RESEARCH ARTICLE

Psycho-Sociological Impact of Learning from Home during Covid'19 Pandemic Outbreak on the Education of Primary School Children with Special Reference to Rural Areas

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ABSTRACT

The Covid'19 stuns the world and stagger the world economy. Irrespective of the sectors and departments, it affected the all the sectors and departments in the world. In which, one of the most affected department is education department. In the state of Tamil Nadu, last one year the schools are closed and students learning through channels and online mode through internet. In specific, the primary schools are not yet opened though higher classes are gradually come to normal. This study aimed to find out the impact of COVID'19 pandemic Lockdown on the education of the Primary school Children; studying 1st Standard to 5th Standard. Practically it was difficult for practicing these kids to attend the class through digital mode without facing their teacher in person. Moreover parents are also felt difficult to create a class room atmosphere at home and to bring the kids in to study table. By considering the future of these kids, a study was needed to understand the reality of reach of the digital mode classes and to know the present knowledge level of these kids after lockdown. The students studying primary classes in Trichy district alone taken for consideration and the samples are chosen from 14 rural educational blocks in Trichy district. The results may or may not applicable for the whole state of



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Tamil Nadu. It is found that the primary school students are not showing interest in online classes and their mental age has been diluted. Bring back them to the normal is too difficult but it is must. Most of the children are attending the Digital classes (TV channel or online classes) by the compulsion of their parents and with the expectation of getting mobile phone for playing games and watching favorite channels. In this research, it is suggested to permit the kids have school atmosphere maximum of two/three days in a week initially by strictly following precautionary measures and to compel the kids to follow the virtual classes daily. Through this research, it is concluded that the COVID'19 pandemic lockdown severally affected the education of the primary school children and needed some remedy to overcome this pathetic situation otherwise various welfare measures implemented by the Government of Tamil Nadu become waste and meaningless.

Keywords: Covid 19 Pandemic, Lockdown, Virtual (Digital) Classes, Primary School Children, Knowledge level, Education in Rural areas

INTRODUCTION

The COVID-19 may be most pronounced word in the year 2020. It affects different people in different ways during the year 2020. One among them is Education department. Covid'19 has disrupted the education, especially primary education, till today it is not being fully recovered. In Tamil Nadu, all the primary school students are missing their school life nearly 12 months since 16th March 2020. This is due to (Schools are being closed since 16th March 2020 to till date [1]. The Tamil Nadu Government has taken public health measures to the control the spread of COVID-19 pandemic and has meant the extended closure of schools. Even the Tamil Nadu government has taken efforts for the continuity in learning and well-being of these children and has implemented virtual learning strategies; it is found that an aggravate education gaps existing in the regions due to pandemic. The major objectives of this research is to finding out the impact of Covid'19 pandemic lockdown on the education of primary school students, say 1st standard to 5th standard studying in schools located in Trichy District. Totally 35,605 schools are available in Tamil Nadu in which 25,81,843 lakhs students are studying LKG to 5th Standard in Government, Government aided and Private schools [2]. The Indian Government has taken more initiatives to achieve universalization of primary education through many schemes [3] to the children in the age group of 5-10 years and ensures the availability of quality of primary education. According to Dr. Pravat Kumar Jena (July 2020) [4], this lockdown deteriorates the continuity in education of the student suffered a loss of nearly 3 months and created difficulty in resuming school again. Generally in India, Initially the educators and learners are not experienced and trained with use of technology in education and this is due to lack of practice and drive towards using technology in the field of education, this created high challenges during pandemic situation [5].

EDUCATION SYSTEM IN THE STATE TAMILNADU

The education structure of Tamil Nadu is based on the national level pattern of 12 years of schooling, i.e., 10+2, which includes eight years of elementary education. During these eight years of elementary education, first five year called primary education (1st Std. to 5th Std.) for the age group of 5 – 10 years and rest of three years will be a middle school education (6th Std. to 8th Std.) to the age group of 11- 13 years, followed by two years of secondary education (9th & 10th Std.) and two years of higher secondary education (11th & 12th Std.), in addition to two years of pre-primary education as LKG & UKG. The entry age in grade 1, i.e. 1st standard is 5+ years age and pre-primary classes from the age group of 3-4 years [6]. The primary education in Tamil Nadu is the period of formal education usually encompasses 1 to 5 and the students acquire basic skills in areas such as reading, writing and arithmetic during this period [7].



**Mohanraj et al.,****STUDENT ENROLLMENT AND STUDY AREA**

This research has been conducted in the primary schools located in Trichy district and offering only Nursery and Primary education. The Trichy district education zone has been divided into 16 blocks [8][9], in which, 14 blocks, such as Andanallur, Manikandam, Thiruverambur, Manapparai, Marungapuri, Vaiyampatty, Lalgudi, Manachanallur, Pullampady, Musiri, Thottiam, Thathaiyangar Pet, Thuraiyur, Uppiliyapuram in Trichy district are considered as rural and 2 blocks (Trichy town & Trichy west) are considered as urban. The study group are studying and residing in rural blocks. Totally 1032 Schools are offering only Nursery and Primary education from these 16 blocks. In which, totally 93,735 are studying the Grade between 1st standard to 5th standard. Out of which, 46,016 boys and 47,719 girls are studying primary education with Net enrollment ratio of 99.83% [10]

STATEMENT OF THE PROBLEM

Post COVID'19 pandemic lockdown gives rise to a number of issues and negative impact on educational knowledge of the children. The students are forced to attend classes through online mode, whether they are willing or not. Though the Government took many initiatives and sets guidelines on conducting online classes, especially for the welfare of the school children, the result is not appreciable. The Schools are squeezing them to maintain its image. In this context, the present study has made an attempt to study the impact of COVID'19 pandemic and remedy for the School children, especially Primary school going students (I Std to V Std.). This is because, it is the first generation have not gone to school for the last one year and experienced the concept of Online Classes. In this study, the impact of COVID'19 on the primary school children has been analyzed.

RESEARCH OBJECTIVES

The research objectives are to find out the major impact on the education of Primary school students due to COVID'19 pandemic lockdown, Psychological effect on online/TV classes (Virtual), impact on their knowledge level relating to mental age, real output of conducting classes through online, students' response towards online classes and real outcome of the same.

RESEARCH METHODOLOGY**Research Design**

Descriptive research design has been used in this research and required data has been collected from different sources. The primary data collected through interview method and secondary data collected through websites and Government published data.

Sources of data and collection procedure

The researcher has used both primary and secondary data. The Primary data are collected fresh from 383 primary school student respondents. As the respondents were being the children, Interview schedule has been adapted with standardized questions for collecting the data. The required secondary data have been collected from books, journals, Press media, websites and Government published data.

Sampling Size and technique

Total number of Primary school students studying in Trichy district is 93,735 from 1032 schools by considering the schools offering primary and pre-primary education. In which, 46,016 numbers of students are boys and 47,719 are girls are studying 1st to 5th standard. In Trichy districts, the Nursery and Primary schools are comes under 16 rural blocks [10]. Out these 16 blocks, 383 samples from 14 rural blocks are taken for conducting survey. Here, the researcher has used cluster sampling technique and the sample size of 383 is calculated through online with 95% confidence level and 5% of margin of error [11].





Analytical Tools

The collected data were analyzed by using proper statistical tools for the requirement of the objectives of the study.

DATA ANALYSIS AND INTERPRETATION

Democratic factors

The following are the democratic factors of sample of 383 students from primary schools. Based on the survey conducted on 383 samples of primary school students studying 1st std. to 5th std., the percentage of boy and girl respondents are 48% and 52% respectively, which shows the girl dominance on primary school students in this study area. In the whole sample, 14% of respondents studying 1st standard, 18%, 20%, 21% and 27% are studying 2nd, 3rd, 4th and 5th standard respectively. Regarding employment of parents, 68% of the student's parents (both Father and mother) are employed and 32% of the respondents' parents either father or mother is employed. 25% respondents are studying in Government schools, 21% and 54% of the respondents are studying in Government aided and Private primary schools respectively. From the above table, it is observed that gender wise standard of study 14%, 18%, 20%, 21% & 27% of the students are studying 1st, 2nd, 3rd, 4th and 5th standard respectively. Regarding gender wise standard of the study, 44% each, 60%, 49% & 42% of the boys students and 56% each, 40%, 51% and 58% of the girls students are studying 1st, 2nd, 3rd, 4th and 5th standard respectively. The Table No. inferred that out of 383 respondents, 74% of them are aware of COVID-19 pandemic and reason for the closure of schools for the last one year and 26% of the respondents are not aware of it. From the above table, it is clear that 64% of the Children are not willing to go to school and the rest of 36% Children are willing to go to school irrespective of the standard of study.

It is also found that the percentage of unwilling students from 1st, 2nd and 3rd standard is more comparatively 4th and 5th standard of students. From the above table, it is clear that out of 138 students willing to go to school, 37% of the students are willing to go to school due to unwillingness for attending online- classes, 22% of them are due to meet and play with friends, 18% of the kids are feel boring at home, 13% of them are due to interested on studies and 10% of them are pressure from their parents. From the above Table No. it is clear that out of 383 respondents, 64% of students are having the knowledge of their standard of study and able to recalling their subjects and 36% of the children irrespective of the standard; forget about their standard of study and not able to recall their subjects. The higher grade students are far better than the lower grade students in this regard. 83% of the kids opined that they are attending virtual classes for getting mobile phone/ TV to play games or to watch favorite channels and least number (06%) of kids are attending the classes due to gain subject knowledge. It is inferred that out of 383 respondents, 84% of them opined that they are not using or referring text books every day and just 16% of the respondents using the same. During this COVID-19 pandemic closure of school period, 55% of the primary school children opined that they are spending majority of their time with digital media followed by playing with friends (31%). 09% for Painting/ Craft work/ Drawing/Home play and 05% for Study related works. Out of 176 students of both Government and Govt. aided schools (Govt. 96+ Govt. Aided 80), 86% of them are unable to get Mid-day meals from the schools due to COVID-19 lockdown and 14% of them are getting mid-day meals through Govt. efforts, like door delivery, etc. It impacts on loss of nutrition to the students, who were depending Mid-day meals.

Hypothesis Testing (ANOVA)

Perception of respondents on the basis of gender about interest on attending virtual class, Concentration on virtual class, Response to Home work, Remembrance of subject and Clarity on topics relevant to subject.

1. H1: There is a significant relationship exist between Gender of the respondents' with interest on attending virtual class.
2. H1: There is a significant relationship exist between Gender of the respondents' with Concentration on virtual class.
3. H1: There is a significant relationship exist between Gender of the respondents' with Response to Home work.
4. H1: There is a significant relationship exist between Gender of the respondents' with Remembrance of subject.



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5. H1: There is a significant relationship exist between respondents' Clarity on topics relevant to subject. (H0 denotes, there is no significant relationship exists between all the five opinions). From the above table, it is clear that all significant value (0.036, 0.338, 0.184, 0.159, 0.152) is greater than 0.05 (at 5% level of significant). Hence, The Alternate hypothesis (H1) of all criteria is rejected. It means, there is no significant relationship exists between gender of the respondents and factors of virtual classes. It is clear that 57%, 70%, 74% and 78% of the students are disagreed about interest on virtual classes, concentration on virtual classes, response to home work, remembrance of subject and clarity on relevance of topic to subject respectively. From the above analysis, the kids are not clear about the topics from which subject it is being taught (82%). From the above table, it is inferred that the High Standard Deviation denotes that the data are wide spread; it means that the primary school students are given variety of opinions and the low standard deviation denotes the given opinion has close relationship and common.

RESEARCH FINDINGS

It is found that almost 74% of the Primary schools students (Sample) are aware of the COVID'19 pandemic, purpose of lock down and reason for the closure of schools for the last one year. 64% of the students are not willing to go to school and 36% of them are willing to go to school. Out of which, 37% of the students are willing to go to school due to unwillingness for attending online- classes. While asking about willingness to go to school, it was observed that psychologically the students are felt tensed about reopening of schools; especially 1st to 3rd standard students felt tensed more comparing with higher classes. 64% of the students have the knowledge of their standard of study and 36% of the kids almost forgot about their standard of study. In which, students are studying 3rd and below are poor knowledge in this regard and unable to recall their subjects. According to Suraksha Subedi (2020), in his research, 75.9% of the respondents (75.9%) were nervous due to unable to understand full course content taught in the online classes [12]. Parents of primary school children feel that it is better to let the children repeat same grade in the next academic [13]. 83% of the kids opined that they are attending virtual classes for getting mobile phone/ TV to play games or to watch favorite channels. Majority (85%) of the Students are not using the text book and even not opening the book after the virtual classes are over. During this COVID'19 pandemic closure, 55% of the primary school children opined that they are spending majority of their time with digital media followed by playing with friends (31%). 86% of them are unable to get Mid-day meals from the schools due to COVID'19 lockdown and 14% of them are getting mid-day meals through Govt. efforts, like door delivery, etc. There is no significant relationship exist between gender of the respondents and factors like Interested on virtual class, Concentration on digital class, Response to Home work, Remembrance of subject, Clarity on relevance of topics to subject. The students are mostly given negative response about interest on virtual classes (57%), 70%, 74%, 78% and 82%), concentration on virtual classes (70%), response to home work (74%), remembrance of subject (78%) and clarity on relevance of topic to subject and respectively. The standard deviation denotes that the opinion given by the kids are not uniform and they are given variety of opinions.

RECOMMENDATIONS

A strong educational policy is to be thought of throughout India like in wartime terms, especially to overcome this COVID'19 pandemic situation faced by educational sector. The COVID-19 affected primary education in India and teaches a lesson to us to construct versatility to face this dangers situation and advised us that change is unavoidable [14]. The sudden shift to virtual learning without any having proper designed curriculum on virtual classes, make our students a risk of passive learners and they may losing interest on attention [15]. To overcome these, the researcher has given some recommendations. First of all, it is recommended that if the Government decided to reopen the primary schools, if everything comes to normal, it is better to permit to conduct the classes initially weekly 3 days only, otherwise psychologically it affects the kids and they may dislike to go to school in future, here the parent's role is vital to bring back their wards in normalities. As found that majority of the parents are employed and virtual classes are conducted during day time, it did not reach the wards properly. So, it is recommended to





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conduct the classes at evening time or recorded one. It is also suggested that in the virtual classes not only talking about subjects and also providing stories and fun games. Majority of the online platforms are following the same methodology (delivering only subjects), it should be unique to the level of the primary school students and may be designed to create interest among the kids by attending the virtual classes. Due to this lockdown, the students studying in Government and Govt. aided schools were not able to get free mid-day meals, this severely affected the nutrition level of such students [5], In this regard, the Tamil Nadu government has taken the effort of providing mid-day meals at their door steps in some particular areas, but it has to be extended all the areas, because, we should compromise the hungry and health of kids.

CONCLUSION

It is concluded that the COVID'19 pandemic lockdown severely affected the knowledge level of primary school children, especially the children studying between 1st standard and 3rd standard. It will a collective effort by Government, Teachers, Parents and the society to bring these children in to normality, but it will take few years. This study portrays the negative impact of COVID'19 Pandemic lockdown on the education of primary school children. It is advisable that there should be gradual feeding of subjects towards the mind of kids, definitely we need patient, because they are kids, they are experiencing a new situation what we were not faced in our childhood.

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Table No.1: Respondents' profile from 383 samples

Particulars	Basis	Frequency	Percentage
Gender	Boys	184	48%
	Girls	199	52%
Standard of Study	1 st	54	14%
	2 nd	68	18%
	3 rd	75	20%
	4 th	82	21%
	5 th	104	27%
Occupation of Parents (Both Father & Mother)	Employed Both	260	68%
	Not Employed Both	123	32%
Gender wise Standard of study	1 st	24 Boys/ 30 Girls	44% & 56%
	2 nd	30 Boys/ 38 Girls	44% & 56%
	3 rd	45 Boys/ 30 Girls	60% & 40%
	4 th	40 Boys/ 42 Girls	49% & 51%
	5 th	45 Boys/ 59 Girls	42% & 58%
Category of School	Govt. Schools	96 (B-36/ G-44)	25%
	Govt. Aided	80 (B-52/ G-44)	21%
	Private	207 (B-96/ G-111)	54%

Source: Primary Data (B –Boys, G- Girls)

Table No.2: Students' awareness about COVID'19 pandemic & Reason for Closure of School

Particulars	Opinion	Frequency	Percentage	N
Awareness about COVID'19 pandemic and reason for Closure of school	Yes	282	74%	383
	No	101	26%	

Source: Primary Data

Table No.3: Standard wise students' opinion on willingness to go to school

Standard of Study	Opinion				N
	Yes		No		
1 st Standard	06	11%	48	89%	54
2 nd Standard	15	22%	53	78%	68
3 rd Standard	21	28%	54	72%	75
4 th Standard	36	44%	46	56%	82
5 th Standard	60	58%	44	42%	104





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Total & Percentage	138	36%	245	64%	383
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Source: Primary Data

Table No.4: Reason for willingness to go to school

Particulars	Frequency	Percentage	N
Unwilling to attend On-line classes	51	37%	138
To Meet and play with friends	30	22%	
Interest of Studies	18	13%	
Feel boring at home	25	18%	
Pressure from their parents	14	10%	

Source: Primary Data

Table No.5: Opinion of the respondents' knowledge on their standard of study and ability to recalling the subjects

Particulars	Opinion				N
	Yes		No		
1 st Standard	15	28%	39	72%	54
2 nd Standard	32	47%	36	53%	68
3 rd Standard	45	60%	30	40%	75
4 th Standard	56	68%	26	32%	82
5 th Standard	96	92%	08	08%	104
Total/ Percentage	244	64%	139	36%	383

Source: Primary Data

Table No.6: Reason for attending virtual classes

Particulars	Frequency	Percentage	N
To get mobile/ TV to play games or to watch favorite channels	318	83%	383
To gain subject knowledge	022	06%	
Fear on class teacher/ parents	043	11%	

Source: Primary Data

Table No.7: Opinion on referring the text books by the students

Particulars	Opinion	Frequency	Percentage	N
Opinion on using or referring the text book	Yes	063	16%	383
	No	320	84%	

Source: Primary Data

Table No.8: Opinion on everyday spending majority of the time during this COVID'19 pandemic closure of school

Particulars	Frequency	Percentage	N
Study related works.	019	05%	383
Playing with friends	118	31%	
Painting/ Craft work/ Drawing/Home play	036	09%	
Spending time with digital media	210	55%	





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Table No.9: Opinion on unable to get Mid-day meals due to COVID'19 lockdown & Loss of nutrition by the Govt. & Aided schools students

Particulars	Opinion	Frequency	Percentage	N
Unable to get Mid-day meals due to lockdown	Yes	151	86%	176
	No	025	14%	

Table No.:10 – Relationship between Democratic factors and other criteria (ANOVA)

Gender	N	Mean	Std. Deviation	Sum of Squares	df	Mean Square	F	Sig.
Male	184	41.9255	10.26546	362.552	2	362.522	3.525	.067
Female	199	40.6623	10.37028					
Total	383	41.4801	10.31486					

Table No.:10 (a) - Relationship between Democratic factors and other criteria (ANOVA)

Factors	Gender	N	Mean	Std. Deviation	Sum of Squares	df	Mean Square	F	Sig.
Interested on Virtual class	Boys	184	5.9122	1.82139	16.807	2	16.809	4.832	.036
	Girls	199	5.5246	1.98094					
	Total	383	5.8172	1.88256					
Concentration on Virtual class	Boys	184	6.5437	2.03942	3.853	2	3.755	0.875	.338
	Girls	199	6.2050	2.09903					
	Total	383	6.3670	2.06046					
Response to Home work	Boys	184	11.3876	3.67949	24.368	2	24.378	1.687	.184
	Girls	199	10.9615	3.73011					
	Total	383	11.1751	3.69881					
Remembrance of subjects	Boys	184	18.3876	5.49538	64.987	2	65.963	2.201	.159
	Girls	199	17.8324	5.79232					
	Total	383	18.1827	5.60469					
Clarity on relevance of topics to subject	Boys	184	18.4812	5.49538	53.838	2	54.937	2.305	.152
	Girls	199	17.8337	5.79232					
	Total	383	18.2021	5.60469					

Table No.11: Opinion of the students on virtual classes

Study Elements	Agreed	No opinion	Disagreed	N
Interested on Virtual classes	61	104	218	383
	16%	27%	57%	
Concentration on Virtual classes	75	38	270	383
	20%	10%	70%	
Response to Home work	52	46	285	383
	14%	12%	74%	
Remembrance of subjects	51	32	300	383
	13%	08%	78%	
Clarity on relevance of topics to subject	43	28	312	383
	11%	07%	82%	

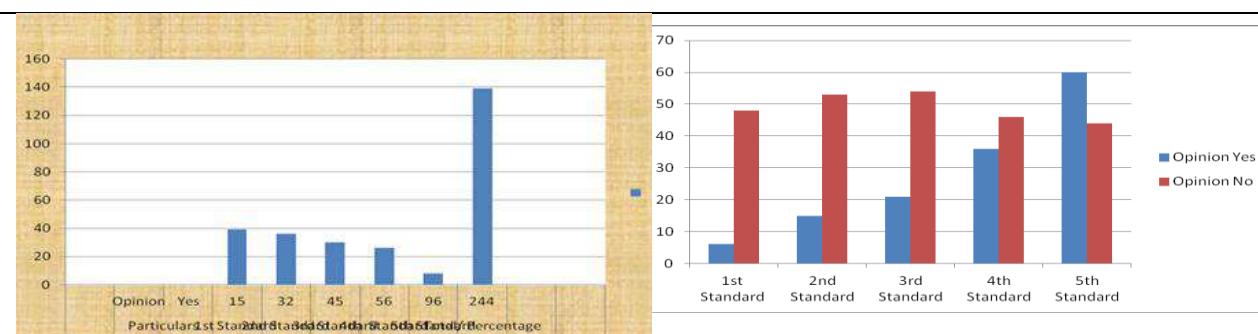
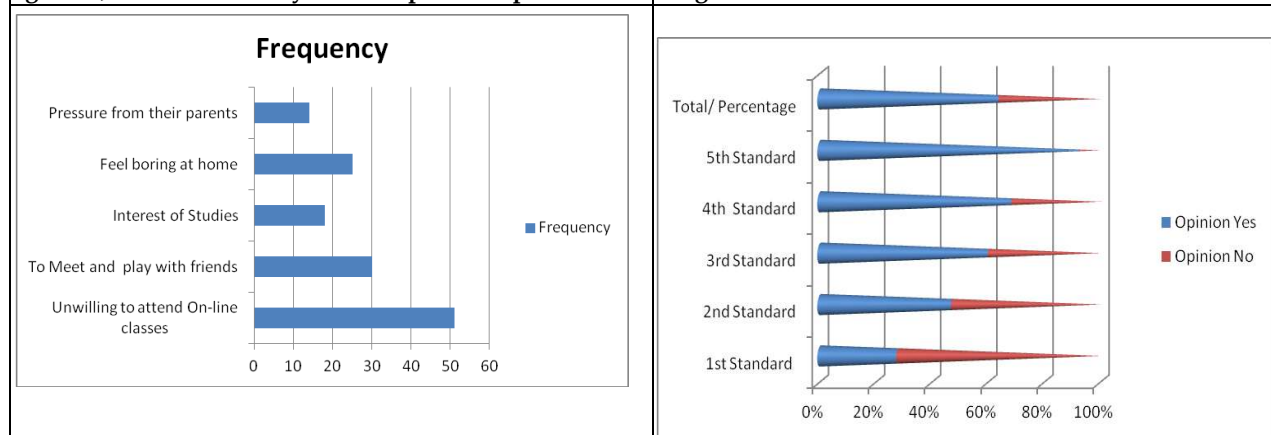
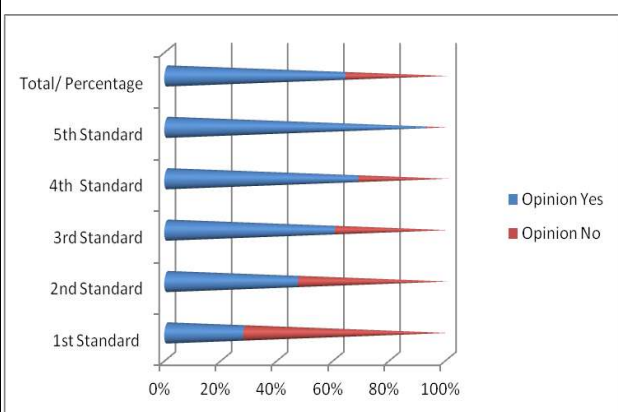




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Table No.12: Standard and mean deviation on opinion of respondents

Study Elements	N	Minimum	Maximum	Mean	Std. Deviation
Interested on Virtual class	383	3	8	5.75	.91
Concentration on Virtual class	383	2	8	5.70	.76
Response to Home work	383	3	8	5.67	.81
Remembrance of subjects	383	2	8	5.34	1.02
Clarity on relevance of topics to subject	383	3.66	8	5.68	.726

**Fig.1 showing respondents' demographic profile like gender, standard of study and occupation of parents****Fig. 2 Standard wise students' opinion on willingness to go to school****Fig. 3 Reason for willingness to go to school****Fig. 4 Opinion of the respondents' knowledge on their standard of study and ability to recalling the subjects**



Navigating Sustainability - A Study on ESG Integration on Firm Performance of Indian Companies

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ABSTRACT

In the past, investors prioritized quantitative and objective characteristics while choosing investments. Growth, financial positions, profit, dividend pay-out, financial ratios, and peer comparison are standard parameters. This method was best for solo analysis. Investors and organizations have realized they are part of a broader ecosystem. They recognize that a mutually beneficial relationship with the environment and society is essential for long-term existence. Governance is a foundation and directs the environmental and social pillars of sustainability. Today, firms must have a larger goal than just profit. The triple bottom line is more emphasized as it embraces economic, social, and environmental sustainability. This study examines how environmental, social, and governance (ESG) practices affect the financial performance of the top 50 Indian corporations listed by the National Stock Exchange (NSE) for 2021–2022. The data used for this research was taken from CRISIL ESG Scores 2022. Corporate value and profitability are regularly used to evaluate corporate performance. Tobin's Q values companies, while ROA measures their profitability. The findings derived from Tobin's Q analysis suggest a positive impact of ESG Practices. It has been established that individual ENV, SOC, GOV, and the aggregate ESG score positively affect corporate value. The return on assets (ROA) analysis also showed that environmental, social, and governance (ESG) components and the composite ESG score affect business profitability. This study also considered the individual pillar-wise ESG scores and the aggregate ESG score to assess business performance, unlike previous research that only considered one dimension or an overall ESG score. In addition, this research used firm value (Tobin's Q) and firm profitability (ROA) to analyze how environmental, social, and governance (ESG) variables affect Indian companies.





Keywords: ESG practices, firm performance, Indian Companies, Tobin Q, ROA, Firm value.

INTRODUCTION

Sustainability and corporate responsibility-related issues are sometimes called "Environmental, Social, and Governance (ESG)" issues. The impacts on ecosystems and communities are at the heart of these discussions. In light of the climate disaster and the increased significance of diversity, inclusiveness, and equality, companies, regulators, investors, and other stakeholders are increasingly focusing on these concerns. Responsible investing is gaining traction, and one technique for doing so is incorporating environmental, social, and governance (ESG) considerations into investment practices and choices. Individuals with socially solid preferences, as identified by Riedl and Smeets (2017), are more likely to invest their money into socially responsible funds than into more traditional ones, despite the latter's potential for higher returns. By proactively assessing possible problems, ESG risk management helps businesses achieve long-term growth that won't derail the economy. Organizations are given more time to adapt and develop solutions to reduce associated costs if they are made aware of potential dangers sooner rather than later. In evaluating the overall risk and possible return of an investment, investors place a premium on how well a company manages risk related to environmental, social, and governance (ESG) aspects. Yoon et al. (2018) report a worldwide pattern of firms voluntarily engaging in ESG practices, which may indicate the existence of financial incentives for doing so. Companies have shown a growing propensity to disclose ESG (environmental, social, and governance) information. Lokuwaduge and Heenetigala (2017) show that the credibility of its ESG practices greatly impacts a company's commitment to ESG disclosure.

Companies may maintain and improve their reputation in the face of stakeholders' scrutiny and social media's impact by using ESG disclosure as a strategic instrument for impression management (Brammer & Pavelin, 2008). Globally, ESG investments are proliferating. According to research by Bloomberg Intelligence, environmental, Social, and Governance (ESG) assets are expected to grow to more than \$53 trillion by 2025. Over a third of the estimated \$140.5 trillion in Total Assets Under Management (AuM) is predicted to come from this sum. Increased investor demand, changing regulatory requirements, and the emergence of numerous ESG funds all contribute to the recent surge in asset allocations prioritizing environmental, social, and governance (ESG) aspects. Similarly, the meteoric rise of ESG funds in India over the past four years reflects the observable pattern. From \$283.5 million (INR 2,268 crore) in March 2019 to \$1.5 billion (INR 12,447 crore) in March 2022, the AUM of these funds has increased significantly. Thomson Reuters Asset, Bloomberg, MSCI, S&P Global, Refinitiv, CRISIL, MOODY'S, Dow Jones Sustainability Index, etc, are some of the rating agencies that track and rate the environmental, social, and governance (ESG) performance of thousands of companies every year and makes information accessible to the shareholders, investors, regulators, and other interested parties. Despite having existed for quite some time, systematic ESG reporting and analysis is a relatively recent discipline in India. The Sustainable Stock Exchange Initiative (SSE) of the United Nations works with stock exchanges to foster the sustainability agenda. According to SSE (2022), 66 of the 120 member stock exchanges have published criteria for environmental, social, and governance (ESG) reporting by corporates.

ESG Reporting in India

The Indian government's Ministry of Corporate Affairs (MCA) issued its Voluntary Guidelines on Corporate Social Responsibility in 2009, marking the beginning of ESG reporting in the country. Business Responsibility Reporting (BRR), Corporate Social Responsibility (CSR), Integrated Reporting (IR), National Guidelines for Responsible Business Conduct (NGRBC), and, most recently, the Business Responsibility and Sustainability Report (BRSR) have all been added to the reporting framework since then. Environmental, Social, and Governance (ESG) reporting has been required since 2012, according to rules established by the Securities and Exchange Board of India (SEBI). According to this rule, the 100 largest publicly traded companies by market value must file a Business Responsibility Report. It was later decided to broaden the initiative's focus to include the 500 largest publicly traded companies



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worldwide as of 2015, based on their market capitalizations. On May 10th, 2021, the Securities and Exchange Board of India (SEBI) launched a new reporting framework called the Business Responsibility and Sustainability Report (BRSR). Top 1000 listed companies in market capitalization are made mandatory to report on the material environmental, social, and governance (ESG) risks and opportunities related to their operations by the BRSR (Business Responsibility and Sustainability Reporting) framework for 2022-23. Furthermore, these companies need to give an overview of their plans for responding to and adjusting to these risks while keeping the monetary costs in mind. The measure was implemented to ensure openness and accountability for all parties involved.

REVIEW OF LITERATURE

Independent and dependent variables are discussed, and hypotheses are developed from the reviewed literature.

ESG Practices and Firm Performance

There is a contemporary trend of stakeholders evaluating businesses based on short-term profits and considerations like sustainability and long-term value creation. Organizational value can be significantly impacted in both the short and long term by addressing ESG factors. Their importance has expanded as organizations increasingly focus on generating fair and inclusive value over the long run. Environmental, social, and governance (ESG) factors have been shown to affect company success (Friede et al., 2015; Zumente & Bistрова, 2021). There is evidence that environmental, social, and governance (ESG) factors considerably impact corporate profits (Efimova, 2018). Several international studies show a link between a company's Environmental, Social, and Governance (ESG) ranking and its financial success. Xie et al.'s (2019) research analyses how various environmental, social, and governance (ESG) activities relate to the bottom lines of numerous multinational corporations. According to the results, many ESG projects have a beneficial effect on bottom-line results. More stringent disclosure laws are associated with larger organizations hiring more qualified managers, boosting financial performance (Hamelin & Weisbach, 2012). Swami et al. (2016) state that ESG screening has not significantly impacted the financial performance or risk profile of businesses. Duque-Grisales and Aguilera-Caracuel (2021) state that ESG (environmental, social, and governance) concerns can significantly affect the bottom line and the value of a company. Environmental, social, and governance measures taken by corporations have been shown to positively affect innovation performance in a study by Freiberg et al. (2019), as emphasized by Zhang et al. (2020). Environmental, social, and governance (ESG) aspects are investigated in the financial performance of 4887 companies between 2014 and 2018 in the study by Bhaskaran et al. (2020). As independent variables, the authors use measures of company value (as determined by Tobin's Q) and operational performance indicators (ROE and ROA, respectively).

ESG and Firm Value.

In four nations—China, Denmark, Malaysia, and South Africa—the study by Ioannou and Serafeim (2012) examined the effects of regulatory requirements on the disclosure of environmental, social, and governance (ESG) information. The study's findings suggested a positive association between sustainability disclosure regulations and the valuations of participating firms. Several studies have shown a positive and statistically significant association between the combined score of environmental, social, and governance (ESG) variables and company value. Aydomuş et al. (2022) found a positive and statistically significant correlation between individual social and governance ratings and company value. Still, they found no such correlation between the environment score and value. During the decade between 2007 and 2016, Buallay (2019) studied 342 financial institutions in the top 20 nations that made the most progress toward attaining sustainable development goals. The study aimed to determine how environmental, social, and governance (ESG) issues affect market performance. The study's results to the value creation idea by showing a link between ESG considerations and financial returns. However, it can be claimed that ESG issues hurt financial and operational performance, consistent with the cost-of-capital reduction theory. Naeem et al.'s (2022) research analyzes how the performance of ESG (environmental, social, and governance) affects bottom lines. Tobin's Q is used as a proxy for market capitalization, and the authors show a positive and statistically significant association between ESG ratings and market capitalization. As a result of this discussion, the following conjecture can be made:



**Niveditha and Nirmala****ESG and Firm Profitability**

There is a statistically significant link between a company's profitability and its ESG total score. Each part of the ESG score—environment, social, and governance—correlates similarly. Since the pandemic has had such a profound effect on economies and societies worldwide, it is not surprising that investors and businesses have recently shown increased interest in ESG ratings, which incorporate not only accounting practices but also governance and social impact measures. Daz et al. (2021) conducted research that hints at the "hidden" hazards faced by corporations that ignore their social responsibilities and engage in inefficient governance practices. While Talento et al.'s (2019) research found that individual ESG scores had no bearing on performance, it did find that out-of-the-ordinary ESG results had a favorable correlation with industry norms. Evidence shows that a company's size is a meaningful contextual factor, frequently indicating the presence or absence of discretionary resources. To remain competitive in today's market, businesses must fulfill their stakeholders' social, environmental, and governance obligations. The number of ESG funds, their average AUM, and their inflows have all increased dramatically in recent years. Based on the risk-adjusted performance metrics analysis results, it is clear that many of the funds have outperformed the market portfolio in 2021 and during the given time frame (Sarkar, 2022). The effect of environmental, social, and governance (ESG) performance on financial success is the subject of research by Naeem et al. (2021). The authors show a positive and statistically significant relationship between ESG ratings and profitability as assessed by return on assets (ROA) for individual and aggregated scores. Therefore, the following hypothesis has been developed as a result of the preceding discussion: It is expected that increased firm value and profitability may result from enhanced ESG ratings based on the complete analysis of existing data, which considers the increased attention from investors and the public perception of the organization. The following theories will be tested in this investigation:

Hypothesis 1. ESG scores have a positive and significant impact on firm value

Hypothesis 2. ESG scores have a positive and significant impact on firm profitability

Numerous scholarly investigations and empirical analyses conducted in finance indicate a favorable correlation between Environmental, Social, and Governance (ESG) factors and the value and profitability of firms. Nevertheless, prior studies have shown many unfavorable and inconclusive findings. This study aims to contribute to the ongoing debate by utilizing a substantial, up-to-date, and extensive dataset.

DATA AND METHODOLOGY

This section provides an overview of the sample data, followed by a detailed description of the variables, a presentation of descriptive statistics, and an explanation of the methodology employed in the study. Two-panel data models are employed for each dependent variable, resulting in four models for each independent variable.

Sample Data

The current study has used the ESG Scores of the top 50 companies in terms of Market Capitalization as per the NSE Website for 2021-22. These 50 companies belong to 9 sectors measured by CRISIL.

Dependent Variables

This research uses market-based and accounting-based measures of a company's success (Gentry & Shen, 2010). As a result, company performance has been measured through two surrogates: market capitalization and profitability. Based on the work of Jang, Lee, and Choi (2013), Mishra and Suar (2010), and Simpson and Kohers (2002), this study expands on their findings. Tobin's Q is often used as a proxy for firm value in market-based business performance assessments in developing economies. According to Kim, Chung, and Park (2013), Tobin's Q is a financial indicator that "measures the extent to which a company's market value exceeds the value of its tangible assets." Consequently, businesses with higher Tobin's Q ratios are more valuable than those with lower ratios. The formula below is used to carry out the calculation. Tobin's Q is the ratio of a company's market value to its book value. Since its introduction, return on assets (ROA) has become a standard indicator of financial performance in accounting-based evaluations (Gryphon & Mahon, 1997). Investors may use it as a proxy for overall company success (Scott, 2003); therefore, it is essential to keep that in mind. The following equation is applied to calculate return on assets (ROA): The ratio of a





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company's net income to the average of its total assets is known as its return on assets (ROA), a financial indicator used to assess its profitability.

Independent variables

The study includes four independent variables: the environment score, the social score, and the governance score, for a total of the ESG combined score. All of the ESG scores used in this analysis are from Crisil ESG Scores 2022. CRISIL's Environmental, Social, and Governance (ESG) scores are used to aid financial institutions and corporations in evaluating and monitoring the ESG risks inherent in their stock and debt holdings. The evaluation is based on data made public by the firms, such as information from their websites, exchange filings, annual reports, investor presentations, sustainability reports, and CDP filings. It also includes relevant ESG information readily available from credible sources, such as that disclosed by trade associations, government agencies, and other organizations. The rating is based on a combination of quantitative data and qualitative disclosures.

Descriptive Statistics

NSE Top 50 companies are taken. Tobin's Q and Return on Assets (ROA) are the dependent variables, and ESG_CS, Environment, Society, and Government (ESG_CS, ENV, SOC, and GOV) are the independent variables. The descriptive data are shown in Table 1. Return on assets (ROA) is 10.04 percent, whereas Tobin's Q averages 2.35 percent. The stock may be overpriced if Tobin's Q is more than one. A sizeable fraction of the businesses in our sample are overpriced. A higher return on assets (ROA) indicates increased profitability for a business. A return on assets (ROA) of 5 percent or more is generally considered successful. According to the data, most businesses are pretty effective at turning their resources into cash flow, with a mean return on assets (ROA) of 10.04 percent. The average ESG (environmental, social, and governance) scores are as follows: 62.14 for the combined score, 54.82 for the environment, 58.26 for social, and 70.90 for Governance. Governance and social indicators are higher than environmental ones. It is also important to note that all variables have standard deviations inside the norm.

Methodology

Tobin's Q and return on investment (ROI) models are used to analyze the data and draw conclusions for this study. Numerous studies, such as those by Giannopoulos et al. (2022) and Naeem et al. (2022), have included Tobin's Q and ROA as dependent variables. Since the independent variables (ESG_CS, ENV, SOC, and GOV) are correlated, multiple models consider them separately. To estimate the results, we ran a total of eight models.

$$TQ_{it} = \beta_0 + \beta_1 ESG_CS_{it} + \epsilon_{it}$$

$$TQ_{it} = \beta_0 + \beta_1 ENV_{it} + \epsilon_{it}$$

$$TQ_{it} = \beta_0 + \beta_1 SOC_{it} + \epsilon_{it}$$

$$TQ_{it} = \beta_0 + \beta_1 GOV_{it} + \epsilon_{it}$$

$$ROA_{it} = \beta_0 + \beta_1 ESG_CS_{it} + \epsilon_{it}$$

$$ROA_{it} = \beta_0 + \beta_1 ENV_{it} + \epsilon_{it}$$

$$ROA_{it} = \beta_0 + \beta_1 SOC_{it} + \epsilon_{it}$$

$$ROA_{it} = \beta_0 + \beta_1 GOV_{it} + \epsilon_{it}$$

where TQ_{it} and ROA_{it} are dependent variables, ESG_CS_{it} , ENV_{it} , SOC_{it} , GOV_{it} are independent variables, ϵ_{it} is the error term for firm i in period t .

Impact of ESG measures on ROA:

Pearson correlation coefficients were used to study the link between ROA and ESG measures, including sustainability performance and social responsibility. The ROA was considered dependent, whereas the ESG indicators were treated as independent factors. A multiple regression analysis was carried out to dig even deeper into this connection. The data was tabulated and presented below.: One way to measure the closeness of a relationship between two variables is with a coefficient of correlation. Table 2 shows a positive and statistically significant relationship when analyzing the relationship between the return on assets (ROA) and the independent variables that make up environmental, social, and governance (ESG). Return on assets (ROA) has a moderately



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positive link with social aspects (0.424) and a moderately positive correlation with governance elements (0.580), according to the correlation value. The association between ROA and integrated ESG measures indicates a substantial positive correlation, with a correlation coefficient of 0.732. Concerning Table 3, ANOVA results indicate that the regression model is statistically significant in predicting ROA as $p < 0.05$ ($p=0.000$). Table 4 displays the unstandardized coefficients from the multiple regression model, which explains how ESG measures affect ROA for different types of businesses. The coefficient reveals the correlation between the dependent and independent variables, each measured on their own scales. We normalized the coefficients to measure how much each independent variable affected the dependent variable. This research found that the Environment variable was the most influential ($r = 0.512$). The Governance Factor came in second with a rating of 0.344, and the Social Factor came in third with a value of 0.213. The Return on Assets (ROA) is significantly influenced by incorporating Environmental, Social, and Governance (ESG) indicators, with an r -squared value of 0.493. The statistical analysis shows that all independent variables significantly affect return on assets (ROA) because their p -values are less than 0.05 ($p < 0.05$).

The regression equation for ROA

$$\text{ROA} = 35.684 + 0.434(E) + 0.215(S) + 0.318(G)$$

From Table 5, we may infer that the simple correlation coefficient (R) value is 0.807, indicating a high degree of connection. In addition, the R^2 value is 0.620, which indicates that the independent factors explain 62% of the variation in the dependent variable, which is companies' return on assets (ROA).

Impact of ESG measures on Tobin Q

The correlation between Tobin Q and ESG measures was analyzed using Pearson correlation coefficients. The researchers used a multivariate regression analysis, with ESG readings as the independent variables and Tobin Q as the dependent one. Standardized values for all constructs were first calculated so that regression analysis could be performed. The data is presented in the tables below. The correlation coefficient can measure the degree of association between two variables. Table 6 shows a positive and statistically significant relationship between Tobin Q and all of the ESG parts, the independent variables. Tobin Q has a moderately good association with social and governance characteristics ($r = 0.589$) and a substantial positive correlation with environmental elements ($r = 0.766$). Tobin Q and combined ESG readings correlate positively ($r = 0.700$). Concerning Table 7, ANOVA results indicate that the regression model is statistically significant in predicting Tobin Q as $p < 0.05$ ($p=0.000$). Table 8 displays the multiple regression coefficient, which explains how ESG indicators affect the unstandardized Tobin Q of businesses. The coefficient reveals the correlation between the dependent and independent variables when measured on separate scales. The significance of the relationship between the independent and dependent variables was calculated using the standardized coefficients. The environment component was shown to have the most significant influence in this research, with a value of 0.643. The governance factor ranked last with a rating of 0.210, and the social factor ranked third at 0.321. The value of 0.282 in connection to Tobin Q is discovered to be significantly impacted by the incorporation of environmental, social, and governance (ESG) indicators. All of the independent factors greatly affect the return on assets (ROA), as shown by the fact that all of the corresponding values are statistically less than 0.05 ($p < 0.05$).

The regression equation for Tobin Q:

$$\text{Tobin Q} = 11.107 + 0.641(E) + 0.318(S) + 0.244(G)$$

From Model Summary Table 9, we can infer that the simple correlation R -value is 0.855, signifying a high degree of correlation. R^2 value being 0.707, which indicates that the Independent Variables explain 70.7% of the variability of the dependent variable Tobin Q in Companies.





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CONCLUSION

This research examines how Environmental, Social, and Governance (ESG) performance affects corporate valuation and financial performance. Data from 50 firms was used in the study. Multiple regression and correlation analyses were used to analyze the data. The results showed a strong correlation between the firm's ROA, Tobin's Q ratio, and ESG scores. The environment had the highest correlation compared to social and governance variables. Environmentally conscious investment decisions by corporations result in the following. By producing biodegradable products, they achieve zero carbon emissions, use renewable energy sources like solar panels, reduce electricity use, reuse byproducts, practice effective waste management, green supply chain management, and other sustainable practices. These investments help businesses implement innovative environmental technology and processes to reduce costs, mitigate risk, and explore new markets. Thus, the company's profitability and value rise. The combined ESG score (ESG_CS) and profitability have a strong and statistically significant positive correlation. Profitability has a strong positive correlation with environmental (ENV), social (SOC), and governance (GOV) factors, which is consistent with stakeholder theory and prior research. Shareholders, investors, creditors, and governments expect corporations to perform well in ESG areas. When companies meet or exceed these expectations, they may receive market rewards. The positive correlation between ESG factors, CSR, business value, and profitability shows this. Our study shows that business managers should invest more in ESG activities. Our findings also emphasize the need for policymakers to pass and enforce ESG laws. Future research should examine the relationship between categories like resource use, emission, innovation, workforce, human rights, community, CSR strategy, compliance, transparency, etc, which form the three pillars of sustainability with the individual scores and combined ESG scores and also its impact on ESG performance, business value, and profitability.

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Table 1 Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
TobinQ	.03	9.16	2.35	2.66
ROA	-13.45	49.91	10.04	10.27
E	33.00	81.00	54.82	11.59
S	39.00	70.00	58.26	5.86
G	50.00	81.00	70.90	7.01
ESG	47.00	76.00	62.14	6.90





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Table 2: Correlation between ROA and ESG measures

	ROA	E	S	G	ESG
ROA	1				
E	.745**	1			
S	.424**	.583**	1		
G	.580*	.598**	.578**	1	
ESG	.732**	.776**	.633**	.632**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3: ANOVA table for ROA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2962.428	4	740.607	20.974	.000
	Residual	1588.952	45	35.310		
	Total	4551.380	49			

Table 4: Multiple regression coefficients for ROA

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	35.684	9.786		3.647	.001
	E	.434	.156	.512	2.776	.008
	S	.215	.138	.213	2.106	.026
	G	.318	.110	.344	-2.877	.006
	ESG	.698	.278	.493	2.512	.016

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.807	.651	.620	5.94223

Table 6: Correlation between Tobin Q and ESG measures

	Tobin Q	E	S	G	ESG
Tobin Q	1				
E	.766**	1			
S	.589**	.637**	1		
G	.554**	.587**	.626**	1	
ESG	.700**	.718**	.687**	.637**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 7: ANOVA table for Tobin Q

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	35.826	4	8.956	30.593	.000
	Residual	13.174	45	.293		
	Total	49.000	49			





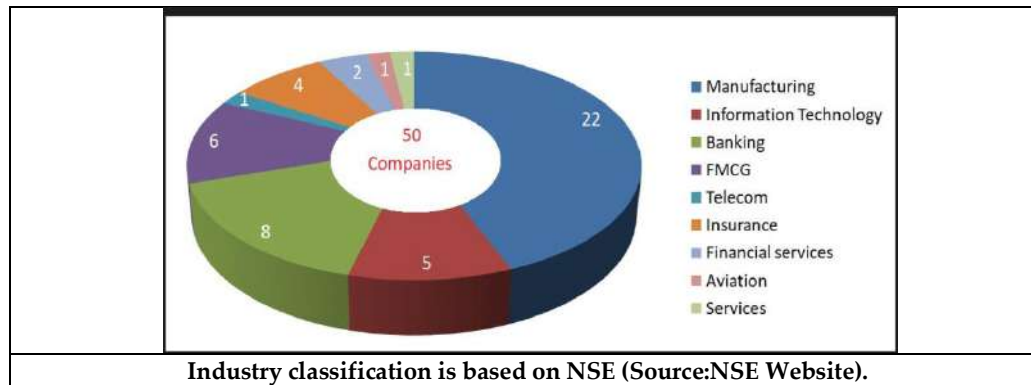
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Table 8: Multiple regression coefficients for Tobin Q

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.107	1.884		5.895	.000
	E	.641	.125	.643	5.121	.000
	S	.318	.104	.321	3.199	.002
	G	.244	.098	.210	2.101	.044
	ESG	.292	.136	.282	2.075	.032

Table 9: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.855	.731	.707	.54107547





Digital Transformation in Strategic Marketing: Trends, Challenges, and Implications for Firms

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ABSTRACT

The computerized time has introduced in a insurgency within the field of key promoting, with businesses adjusting to computerized change at an uncommon pace. This writing study paper investigates the energetic scene of computerized change inside the domain of key showcasing, shedding light on later patterns, challenges, and the significant implications for firms. Drawing on the hypothetical establishments and models within the field, we set the arrange for an in-depth investigation of computerized promoting patterns. We exhibit the foremost later and significant methodologies embraced by businesses and display compelling case ponders outlining fruitful computerized showcasing changes, utilizing computerized innovations and leveraging enormous information to pick up bits of knowledge into buyer behavior. In differentiate, the paper moreover dives into the challenges and boundaries confronted by businesses when executing advanced showcasing methodologies. This segment highlights the basic significance of information in personalizing promoting endeavors whereas tending to protection and security concerns. The developing significance of Omni channel showcasing is additionally explored, enumerating how companies coordinated their online and offline endeavors to form consistent client encounters. All through the paper, we underline the suggestions of advanced marketing transformation for firms, from enhancing business execution to reshaping the parts of showcasing experts. This comprehensive study paper solidifies important experiences for businesses, analysts, and experts looking for to get it and tackle the potential of advanced change in key promoting.



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Keywords: Digital transformation, strategic marketing, digital marketing, trends, challenges, data analytics, consumer insights, Omni channel marketing.

INTRODUCTION

Background and Context of Digital Transformation in Marketing

The digital age has catalysed transformative shifts in promoting, rethinking how businesses interface with their clients. Nowadays, customers are engaged with data and lock in with brands through computerized touch points, driving to a worldview move in promoting honours. As Kaplan and Haenlein (2010) famous, social media and computerized advances have enabled clients, permitting them to effectively take part in promoting discussions. In this setting, businesses must grasp computerized change to remain competitive.

Significance and Relevance of the Review

The noteworthiness of this writing survey lies within the have to be comprehend the suggestions of computerized change in promoting. Digitalization isn't simply an choice; it's a principal prerequisite for firms to stay pertinent and beneficial. The American Promoting Affiliation (AMA) emphasizes the criticality of keeping pace with the energetic promoting scene, expressing that "Showcasing is the movement, set of educate, and forms for making, communicating, conveying, and trading offerings that have esteem for clients, clients, accomplices, and society at huge" (AMA, 2020). As such, understanding the advancing setting and importance of computerized change is crucial for businesses.

Research Objectives

1. Look at later patterns in advanced promoting procedures.
2. Explore the challenges and obstructions firms confront in executing computerized showcasing changes.
3. Analyze the part of information analytics in forming advanced promoting methodologies and the utilization of buyer experiences.
4. Assess the noteworthiness of Omni channel showcasing in conveying consistent client encounters

Structure of the Paper

This paper is organized to supply a comprehensive investigation of advanced change in promoting. Taking after this presentation, the ensuing areas will dive into the different viewpoints of advanced change and its suggestions. These incorporate a survey of later patterns in advanced promoting, outlined through case ponders, and the affect of developing innovations. The paper will conclude with bits of knowledge into future inquire about headings, advertising a all encompassing see of computerized change in vital promoting.

Transformation in Marketing: Conceptual Framework

Definition and Scope of Digital Transformation

Computerized change may be a multifaceted concept that includes the integration of computerized innovations into different viewpoints of an organization's operations to drive significant changes in how it conveys esteem to its partners. Chaffey and Smith (2017) portray computerized change as "the utilize of innovation to profoundly make strides execution or reach of undertakings." This definition highlights the significant affect innovation has in reshaping the way organizations function and associated with their groups of onlookers. Within the setting of vital promoting, advanced change amplifies to the vital appropriation of advanced devices and channels to upgrade showcasing endeavors. Kotler et al. (2017) assert this, expressing, "Advanced change in promoting alludes to the basic changes in showcasing procedures, forms, and organizational structures to use computerized innovations for client engagement and esteem creation." This shows that advanced change isn't simply a innovative overhaul but a crucial move in promoting techniques to superior interface with digital-savvy shoppers.



**Guruprasad et al.,****Relationship between Digital Transformation and Strategic Marketing**

Computerized change and vital promoting share a advantageous relationship. Whereas advanced change gives the innovative framework, key showcasing guides the utilization of these devices for accomplishing organizational objectives. For case, the American Promoting Affiliation (AMA) characterizes showcasing as "the movement, set of educate, and forms for making, communicating, conveying, and trading offerings that have esteem for clients, clients, accomplices, and society at expansive." In a carefully changed scene, these exercises are increased, and the scope of offerings extended through digital channels (AMA, 2020).

Theoretical Foundations and Models Relevant to Digital Marketing Transformation

Hypothetical establishments for advanced showcasing change draw from different areas, counting showcasing, innovation administration, and organizational hypothesis. One unmistakable system is the Innovation Acknowledgment Demonstrate (TAM) by Davis (1989), which clarifies client acknowledgment of innovation, a vital perspective of computerized change. Essentially, the Resource-Based See (RBV) of the firm (Barney, 1991) is important because it investigates how firms can use their interesting assets, counting advanced capabilities, for competitive advantage. Additionally, the McKinsey 7S Demonstrate (Waterman et al., 1980) offers a all encompassing viewpoint on how different variables, counting innovation, connected to shape an organization's advanced change travel. These hypothetical establishments and models serve as focal points through which analysts and professionals can get it, analyze, and actualize advanced promoting change methodologies successfully.

Trends in Digital Marketing**Review of Recent Trends in Digital Marketing Strategies**

The discipline of digital marketing is dynamic and always changing to keep up with the rapidly expanding digital environment. Recent developments in digital marketing techniques cover a variety of techniques intended to increase client interaction and spur company expansion. For instance, content marketing has become increasingly popular, as noted by Pulizzi and Barrett (2015). In order to draw in and keep a target audience while building authority and trust, it includes producing good content. Personalization has also emerged as a key component of digital marketing. Schmitt (2016) underlines the need of adjusting marketing initiatives to meet the specific demands and preferences of each consumer. Marketing professionals can now design highly tailored campaigns thanks to advanced analytics and AI-driven insights, which increase consumer experiences and conversion rates.

Case Studies Illustrating Successful Digital Marketing Transformations

We look at case studies to get a practical knowledge of how digital marketing trends are affecting businesses. According to Shah and Dhawan (2018), HubSpot is a prime example of efficient inbound marketing, showing how content-driven methods, SEO, and email marketing can effectively draw in and nurture prospects. According to Agrawal et al. (2015), Airbnb's user-generated content strategy serves as an example of how utilizing user-generated content may dramatically improve a brand's online presence and consumer trust.

Impact of Emerging Technologies (e.g., AI, IoT, Blockchain) on Marketing Strategies

The integration of developing innovations is forming long-standing time of promoting. Developing innovations, such as Counterfeit Insights (AI), the Web of Things (IoT), and blockchain, are revolutionizing showcasing methodologies. McCarthy and Perreault (2018) emphasize the part of AI in prescient analytics, chatbots, and proposal motors, which improve client intelligent and decision-making. IoT is changing the way items and administrations are showcased. As highlighted by Correia and Putnik (2017), IoT empowers information collection and analysis in genuine time, permitting businesses to offer personalized encounters and make strides item plan. Within the setting of blockchain, the work of Tapscott and Tapscott (2016) diagrams its potential to form straightforwardness and believe in promoting by decreasing extortion and guaranteeing the keenness of supply chains. These patterns and advances collectively outline the energetic nature of computerized showcasing and the require for businesses to adjust to stay competitive in a quickly advancing computerized scene.





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Challenges and Barriers**Identification of Challenges in Implementing Digital Marketing Transformations**

There are difficulties in putting digital marketing changes into practice. Adopting digital strategies and technology presents a variety of challenges for organizations. One significant problem, as emphasized by Smith and Zook (2011), is managing the growing complexity of digital marketing platforms and technologies. Technology and digital channels must constantly adapt and develop due to their dynamic nature.

Organizational and Cultural Obstacles

There are difficulties in implementing digital marketing changes. Adopting digital technology and initiatives presents organizations with a variety of challenges. Managing the growing complexity of digital marketing platforms and technologies is a significant problem, as Smith and Zook (2011) point out. Because technology and digital channels are dynamic, learning and adaptation must be ongoing

Regulatory and Ethical Considerations

The environment of digital marketing's rules and morals is complex and constantly changing. Many academics focus on legal and ethical issues. For instance, Werbach and Hunter (2012) explore the effects of data security, advertising transparency, and online privacy. Marketing professionals must uphold strict ethical standards in order to comply with rules like the General Data Protection Regulation (GDPR) in the European Union, which presents considerable hurdles. It's essential to comprehend these obstacles and issues in order to create efficient digital marketing transformation strategies. To fully take use of the potential of digital technology, businesses must overcome several challenges.

Data Analytics and Consumer Insights**Role of Data Analytics in Shaping Marketing Strategies**

Modern marketing tactics are now shaped in large part by data analytics. To make wise decisions, businesses increasingly rely on data-driven insights. According to Davenport and Harris (2007), data analytics gives firms a competitive edge by helping them to recognize patterns, improve marketing initiatives, and improve consumer experiences. Marketers may make more strategic, data-driven decisions by using data analysis to better understand consumer behavior, preferences, and the success of various marketing activities.

Utilizing Big Data for Consumer Insights and Personalized Marketing

Big data, which is distinguished by its volume, speed, and diversity, has a huge amount of promise for improving customer insights. The authors of a study by Chen and Chiang (2019) stress the significance of using big data to develop customised marketing efforts. Businesses may customize their marketing messages and offers to specific customers by analyzing large datasets, which improves the customer experience and engagement. Increased customer satisfaction and conversion rates are a result of personalization.

Privacy and Security Concerns in Data-Driven Marketing

Concerns about security and privacy are growing alongside the development of data-driven marketing. The acquisition and use of customer data present ethical and legal issues, as discussed by Newman and Forrester (2018). Data security and customer privacy protection are of utmost importance. The need to handle privacy issues is highlighted by the General Data Protection Regulation (GDPR) and other data protection legislation. To sustain customer trust, businesses must be ethical and open in their data operations. Utilizing the potential of data for consumer insights and targeted marketing while preserving trust requires an understanding of the diverse function of data analytics in marketing while resolving privacy and security issues.

Omni channel Marketing**Review of Omni channel Marketing Strategies and Their Adoption**

A complete strategy for consumer involvement across several channels, omni channel marketing ensures a unified and smooth experience. Verhoef et al. (2015) wrote a paper in which the authors stressed the significance of Omni



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channel strategies, defining them as "the systematic and consistent use of channel and customer knowledge to design and deliver customer experiences." The goal of omnichannel marketing strategies is to meet customers where they are by providing a seamless experience that respects and takes into account their channel choices.

Customer Journey Mapping in the Digital Age

Customer journey mapping has become crucial as a result of the customer journey's transformation in the digital era. Lemon and Verhoef (2016) underline the need of charting the customer experience in an Omni channel and multichannel setting in their essay. Businesses can create personalised experiences at each stage by using mapping to identify the touch points and interactions customers have with the brand across channels. It makes sure the consumer journey is very relevant and frictionless.

Integrating Online and Offline Marketing Efforts

An important component of Omni channel marketing is combining online and offline marketing activities. The authors of a case study by Belch and Belch (2019) describe how Nordstrom, a major retailer, successfully combines its online and physical marketing initiatives. The research demonstrates how Nordstrom unifies its online and in-store processes to deliver a uniform brand experience. For organizations trying to connect clients across several platforms and maintain a consistent brand presence, such integration is essential. Businesses looking to engage customers effectively in the digital era need to understand and implement Omni channel marketing strategies, include customer journey mapping, and integrate online and offline marketing activities.

Implications for Firms

Impact on Business Performance and Competitiveness

The adoption of digital marketing changes has a significant effect on the competitiveness and performance of businesses. In their study, Kannan et al. (2016) draw attention to the link between effective digital marketing techniques and increased business success. Businesses that successfully use digital technology to interact with consumers frequently see a boost in revenue, improved customer satisfaction, and a competitive advantage in the marketplace. Additionally, a 2019 research by Sinha and Batra highlights the value of digital marketing in boosting a company's brand equity, which in turn has a favorable impact on business performance.

The Changing Role of Marketing Departments and Professionals

The job of marketing departments and experts has been re imagined in the digital age. In a 2015 paper titled "The Evolution of Marketing Roles," Kotler and Keller emphasize the necessity for modern marketing professionals to be knowledgeable in digital technology, data analytics, and customer experience management. They are essential in developing and putting into practice digital marketing strategy. The role of the marketing department has changed from a conventional promotion-oriented strategy to a more data-driven, customer-centric, and tech-savvy one, as described by De Pelsmacker et al. (2018).

Strategies for Adapting to the Digital Marketing Landscape

For businesses to succeed, they must adjust to the changing world of digital marketing. Smith and Taylor (2020) provide solutions for businesses to successfully handle digital change. Adopting an agile marketing strategy, investing in digital skills and training, and staying current with developing technology are a few of these. In order to achieve a smooth integration of technology in marketing initiatives, businesses must also coordinate their marketing and IT teams, according to Fischer et al. (2017). Businesses that want to flourish in the digital era must comprehend the effects of digital marketing revolutions on their organizations and adapt to the new environment and roles.

Case Studies

In-Depth Analysis of Select Case Studies in Digital Marketing Transformation

Case studies offer insightful information on actual experiences with the shift of digital marketing. In-depth analyses can be performed by researchers to comprehend the approaches, difficulties, and results. For instance, Jain and Yadav's (2020) case study on Coca-Cola's digital transformation provides a thorough analysis of how a major brand



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handled changes in the digital landscape. The influence of the methods used, such as content marketing and social media interaction, on brand success is thoroughly examined in their study.

Lessons Learned from Successful and Unsuccessful Implementations

Case studies give insights from failure deployments in addition to highlighting achievements. The case study by Mayzlin (2019) on the failure of McDonald's "Create Your Taste" campaign offers insightful information in the context of lessons gained. The study looks at operational issues and a lack of customer research as potential causes of its under performance. These case studies are excellent tools for businesses planning to start their digital marketing transformation journeys for deriving useful insights and lessons..

Future Directions and Research Gaps

Emerging Areas and Trends in Digital Marketing Research

New niches and trends are always developing because of the dynamic nature of digital marketing. The study conducted by Karjaluo et al. (2015), for instance, highlights the rising importance of mobile marketing in the digital era. They talk about how new ways for client involvement have been made possible by mobile devices and applications, which have completely changed the marketing environment. A further promising new field is the emergence of social commerce, which Mangold and Faulds (2009) investigated. Researchers now have new chances to study customer behavior and marketing tactics because to the combination of social media and e-commerce.

Unexplored Research Questions and Gaps in the Literature

Despite the abundance of research on digital marketing, there are still unanswered research topics and gaps in the body of knowledge. The study by Li, Li, and Kambele (2019) reveals a gap in our knowledge of consumer behavior in the setting of cutting-edge technology like chatbots and voice assistants. The way customers connect with brands is changing as a result of these technologies, yet there is little study in this field. Serapio and MacKenzie (2018) noted that worries regarding the ethical ramifications of data-driven marketing are underrepresented. Future research projects might benefit greatly from filling these gaps in the literature.

Recommendations for Future Research in this Domain

Recommendations are crucial in order to direct future research. For example, it is crucial that scholars investigate the ethical aspects of digital marketing. Research should examine the moral dilemmas brought on by data collecting, customization, and privacy concerns, as Donthu and Kumar (2021) recommend. Furthermore, it is crucial to analyze how new technologies, like blockchain and artificial intelligence, may affect marketing strategies. According to Jin et al. (2020), researchers should take into account the global viewpoint of digital marketing since various nations and cultures may provide distinct chances and difficulties. Maintaining the relevance and alignment of digital marketing research with the changing landscape depends critically on understanding these future trends and research gaps.

CONCLUSION

Summarize Key Findings and Insights from the Literature Survey

The literature review has offered insightful information on the changing, dynamic world of digital marketing. The main conclusions of this study illustrate the numerous effects of digital marketing on companies and customers. Businesses that adopt digital transformation frequently report improved company performance, increased consumer engagement, and competitive advantages (Kannan et al., 2016; Sinha & Batra, 2019). Additionally, the relevance of multichannel marketing (Lemon & Verhoef, 2016) and the role of data analytics in defining marketing strategies and personalisation have been emphasized (Chen & Chiang, 2019). These results highlight how transformational digital marketing can be in transforming consumer experiences and corporate results.



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Highlight the Significance of Digital Marketing Transformation

It is impossible to overestimate the importance of the digital marketing transition. It has become crucial for businesses to change in order to survive and grow in the digital age. According to Kotler and Keller (2015), in order to stay relevant, current marketing professionals need to be knowledgeable in digital technology and data analytics. For firms trying to keep a competitive advantage, a thorough integration of digital channels, consumer information, and future technology is essential. Effective social media tactics and agile marketing techniques are crucial for success in the digital marketing environment, according to Smith and Taylor's research (2020).

Conclude with Implications for Firms and the Field of Strategic Marketing

The consequences for businesses are obvious. They have to negotiate the difficulties and chances posed by changes in digital marketing. It is essential to adjust to the shifting environment and responsibilities, coordinate marketing and IT departments, and uphold ethical data practices (Fischer *et al.*, 2017; Donthu & Kumar, 2021). Additionally, both practitioners and academics must be aware of unanswered research issues and knowledge gaps in order to advance future understanding (Li, Li, & Kambele, 2019; Jin *et al.*, 2020). In conclusion, digital marketing transformation is at the center of the area of strategic marketing's ongoing evolution. The study offered here offers a thorough review of the prospects and difficulties in this area, providing insightful information for both businesses and scholars.

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RESEARCH ARTICLE

Real Time Expectancy Analyzing of Perspectives Placement Related Activities of the Management Students of Kolkata

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ABSTRACT

The present scenario of management institutes compelling the students as well as their parent to think as company's placement agent due to the lucrative placement promises made by the maximum institutes (Patil2012), but practically, the situation is somewhat different. These institutes are making a lot of commitment regarding the placement activities at the time of admission to the students and based on these commitments, the students expects to get placement but how far these expectations are being fulfilled during the tenure of the course is a matter of concern. Sometime, it is seen that many institutes could not be delivered the expectations of the students, which affect the employability of the students and quality of management graduates pass out from these institutes. The author has tried to discuss in this study some of the expectations of the management students relating to the placement activities and status of fulfillment of those expectations using the tenure of course in the city of Kolkata.

Keywords: Placement activities, expectations, Management Student, Kolkata.

INTRODUCTION

In the present competitive era the management degree is very essential to get a targeted good job and the kind of skills that a student should possess to gain desired placement are essential for placement activities (Mantz& York 2005), reason thereof, the students are running after the management institute for enhancing the employability for fulfilling the dream of hefty compensation package, but at the same time, the institutes are also exploiting the sentiment of the students to get them admitted in their institute. The situation of lacking employability among the management students shows a deteriorating trend of demand for management programme particularly for the





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middle and low ranking institutes and reason thereof, these institutes are slacking the admission criteria for their survival and hence management graduates fall short to increase the employability (Havaladar2012). These institutes are also not in position to fulfil the commitment made to the students at the time of admission in placement areas which affect the employability of the students and quality of management graduates pass out from these institutes (Kwek et al., 2010). In this study, we have tried to find out the status of commitment made and fulfilled by different types of institutes in the city of Kolkata.

LITERATURE REVIEW

A majority of management institutes having the faculty members with no academic as well as industry experience, even not having permanent faculty members and not arranging the faculty development programme (FDP) which affect enhancing the employability skills among the students (Robinson, 2009). Faculty retention is major problem for the institutes due to lack of work environment and payment of less remuneration, ultimately students facing the consequences (Helms (2005). The Academic Institutions should take initiation for Industry -Academia Interface to extend support to conduct various seminar and workshop about present situation of demand in Industry, working condition and hand on training for students to increases the chances of employment (Shetty, et.al 2010). Learning management skills and techniques during internships with hands-on practical work is important for the development of knowledge and success of management graduates at workplace(Tas, 1988; Weligamage & Munasingha, 2006). Students should aware the kind of skills they should possess for desired placement and enhance their employability skills (Mentz& York 2005), but there is some mismatch between student's expectation to learn skills helpful for employment and delivery of such skills during the tenure of their study (Janeen, 2011, Farooq 2011). A survey conducted with 200 respondents from six B-Schools in Pune (Agrawal, 2011) found that students enter with expectation to gain knowledge, good placement, good faculty and access to industry exposure but their expectations are modified which creates a gap between expectation and delivery. These all situation explained above motivates the researchers to conduct the study to find out the real time situation of placement activities among management graduates in the institutes situated in the city of Kolkata (WB).

OBJECTIVES OF THE STUDY

The objective of the study is to analyse the placement related expectation and actual achievement of the MBA students admitted in Maulana Abdul Kamal Azad University of Technology (MAKAUT) formerly West Bengal University of Technology (WBUT) affiliated colleges of Kolkata. The objectives segregated in to the following categories based on following expectations:

1. Objective-1: To find the status of expectation among the students regarding arrangement of pre placement training by industry experts.
2. Objective-2: To find the status of expectations for soft skill training by professionals from industry
3. Objective-3 To find the status of providing value added courses by the institutes to support placement activities
4. Objective-4: To study the expectation of the students regarding project work in reputed industry.
5. Objective-5: Introduction of updated latest course curriculum as per industry requirement.

HYPOTHESIS

Considering the above objective, the following hypothesis has been framed:

Null Hypothesis H₀ The expectations of placement related activities for students have been delivered by the institutes to the Satisfaction level during the tenure of their course. The above hypothesis has further divided in to 5 operative hypotheses mentioned in data analysis section.





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FRAMING OF QUESTIONERS

The survey questioners extracted from the references of the articles of various scholars as under:

1. Pre placement training programme, hands on training in industries and Soft skill training from industry people (Robinson, 2009; Helms, 2005; Mantz & York, 2005; Foster & Carboni, 2009; Ajzen, 1991; Singh & Singh, 2008; Robles, 2012; Pritchard, 2013; Goswami, 2013; Williams, 2015; Bringula, Balcoba & Basa, 2016).
2. Project work in the companies for hands on practical experience (Tas, 1988; Walo, 2000),
3. Updated course curriculum Down (2003), Ishwar (2006) and Shetty, et.al (2010).

RESEARCH DESIGN AND METHODOLOGY

Population

The population comprises the students studying in the final year of MBA conducted by the institutes affiliated under Maulana Abdul Kalam Azad University of technology (MAKAUT), West Bengal. The following table enlighten the college wise intake of MBA for the year 2020 – 22. Though, the actual number of student admitted is 519, but as per the university record the total number of the students remains in the final semester as on 1st January, 2022 (4th semester – January-June, 2022) was 443, which is considered as population for this study.

Sample

The sample size drawn by using the “Slovin’s formula”:

$$n = N / (1 + N \times e^2)$$

Where, n=Number of samples, N= Total population, e=Error tolerance

$$n = 443 / [1 + 443 \times (.05)^2] = 210$$

The sample size as per above formula is 210, and 85 questionnaires were distributed in January 2022 due to pandemic situation and remaining questionnaires send through mail to the available students.

Data Collection

The questioners contained dichotomous type questions with possible answer with “Yes” or “No”.

The questioners contain two parts

1. First part contains expected placement activities of students from institute at the time of admission
2. The second part relates status of fulfilment the expectations during the tenure of the course.

Testing of Questionnaire

Sample of 50 questioners taken for reliability and validity testing, result is as under:

Reliability Test

Cronbach’s Alfa considered to measure the reliability of the questions and the value of Cronbach Alpha is more than 0.7 in each case (Table – III)

Validity Test

The questionnaire is valid if the Pearson correlation value is more than the value of r from table for n-2 (n is the number of respondent) at .05% of significance. The Pearson Correlation computed for the entire questioner is more than the value of “r” i.e. 0.279 for .05 level of Significance and df=48 (n-2=50-2), hence we could consider that questionnaires structured for the study is valid.

ANALYSIS TOOLS

Z-test is a statistical tool used to determine whether two population means are different when the variances are known and the sample is large (more than 30). The mean of the student’s expectation and fulfilment are calculated by using SPSS 20.





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Mathematically z test formula is represented as:

$$Z \text{ Test} = (\bar{x} - \mu) / (\sigma / \sqrt{n})$$

Here,

\bar{x} = Mean of Sample, μ = Mean of Population, σ = Standard Deviation of Population and n = Number of Observation

The Z value calculated by the above formula with the help of Excel

DATA ANALYSIS AND INTERPRETATION

Operative Hypothesis-1

Null Hypothesis (H01): The expectations of the students regarding arrangement of pre- placement training programme from industry people have been arranged by the institutes.

Results of test

Table V shows z-value is 2.1267 and corresponding p-value is 0.033, which is less than the level of significance at 0.05. Hence, we fail to accept the null hypothesis and alternate hypothesis is accepted. Alternate Hypothesis (H11): The expectations of the students regarding arrangement of pre- placement training programme from industry people have not been arranged by the institutes.

Operative Hypothesis-2

Null Hypothesis (H02): The expectations of the student regarding arrangement of soft skill training by the professionals from industry have been arranged by the institutes.

Results of test

Table-V, we can observe that the z-value is 1.8145 and corresponding p-value is 0.0695, which is more than significant level at 0.05. Hence, we fail to reject null hypothesis and alternate hypothesis is rejected.

Operative Hypothesis-3

Null Hypothesis (H03): The expectations of the students regarding add on courses to support the placement activities have been arranged by the institutes.

Results of test

Table-V shows the z-value is 1.4757 and corresponding p-value is 0.14, which is more than the level of significance at 0.05. Hence, we fail to reject null hypothesis and alternate hypothesis is rejected.

Operative Hypothesis-4

Null Hypothesis (H04): The expectations of the students regarding arrangement of project work in reputed industries have been fulfilled by the institutes

Results of test

From Table-V we observe that z-value is 3.3993 and corresponding p-value is .006, which is less than the level of significance at 0.05. Hence, we fail to accept null hypothesis and alternate hypothesis is accepted.

Alternate Hypothesis (H14)

The expectations of the students regarding arrangement of project work in a reputed industry have not been fulfilled by the institutes

Operative Hypothesis-5

Null Hypothesis (H05)

The expectations of the students regarding updated and latest course curriculum as per industry requirements has incorporated in syllabus by the institutes.

Results of test

Table-V shows z-value is 2.1008 and corresponding p-value is 0.0356, which is less than the level of significance at 0.05. Hence, we fail to accept null hypothesis and alternate hypothesis is accepted.



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Alternate Hypothesis (H15): The expectations of the students regarding updated and latest course curriculum as per industry requirements has not been incorporated in the syllabus by the institutes.

FINDINGS

Table V shows the mean score of expectation and fulfilment of expectations by the institutes and based on this analysis we can conclude the following objective wise findings:

Objective-1

Table-V shows the mean square of expectation of pre placement training from industry people is 0.86, which is more than mean square of fulfilment of expectation 0.64. This shows that the institutes have not fulfilled the expectations of the students.

Objective-2

Table-V shows the mean square of expectation fulfilled for frequent soft skill training by professionals from industry is 0.69, which is more than the mean square of expectation by the student is 0.69. This shows that institutes have fulfilled the expectations of the students.

Objective-3

The mean squares of expectation of students for add on courses is 0.78, which is less than the mean square of fulfilment of expectation is 0.86. This shows the institutes have fulfilled the expectations of the students.

Objective-4

Table-V shows that mean square of expectation of arrangement for project work in a reputed industry is 0.90, which is more than the mean square of fulfilment of expectation is 0.70. This shows that the institutes have not fulfilled the expectations of the students.

Objective-5

Table-V shows that mean square of expectation for updated and latest course curriculum as per industry requirement is 0.72, which is more than the mean square of fulfilment of this expectation is 0.58. This shows that institutes have not fulfilled the expectations of the students.

CONCLUSION

The study reveals that some of the area which are very important considering the need of the industries like arrangement for Pre placement training, latest course curriculum as per the industry requirement, project work in reputed industries but unfortunately these areas are not been given attention by the institutes. The study also shows that the institutes under the MAKAUT should be given more importance to the expectations of the students for successful placement of the students.

LIMITATIONS

1. This study is confined to the management institutes controlled by private body and the fees charging is more than the government controlled institutes, hence it is but natural that the expectations of the students will be high compare to these institutes.
2. Due to the closing of the educational institute in the pandemic situation, the response received from the students though e-mail not cover the adequate sample, which may affect the finding of the study.

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Table – I

S. No	Name of the Institutes	INTAKE
1	Institute of Engineering & Management	180
2	Netaji Subash Engineering College	30
3	JIS Engineering College	60
4	Bhartiya Bidya Bhaban	120
5	Techno India	120
6	Army Institute of Management	120
7	Institute of Business Management & Research	30
8	Meghnath Saha Institute of Technology	60
9	Future Institute of Engineering & Management	60
10	Calcutta Institute of Management & Technology	60
11	Brainware Group of Institutions	60
12	Swami Vivekananda Institute of Technology	60
13	Regent Education & Research, Foundation	60
14	Budge Budge Institute of Technology	60
15	NSHM Knowledge Campus	120
16	Pailan College of Management & Technology	30
17	Heritage Business School	180
18	IMS Business School	60
	TOTAL	1470

Table – II

Mode of distribution the questioners	No of questioners distributed	No. of Respondent received	No. of the set of questioners rejected	No. of the set of questioners considered for study
Physically distributed to the students	85	66	14	52
Distributed through E-Mail	140	59	13	46
Sample size for study				98

Table – III

S. No	Attributes	No of Item	Cornbach's Alpha
1	Questioners for expectation of the students	5	.737
2	Questioners for fulfilment of the student's expectation	5	.721

Table-IV

Questionnaire for Student's expectation	Pearson Correlation Computed (r)
Pre placement training from industry people	0.861
soft skill training by professionals from industry	0.894
add on courses by the institutes to support the placement activities	0.743
Project work in a reputed industry	0.674
Updated and latest course curriculum as per industry requirements	0.743





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Questioner for fulfilment of expectations	
The institute has arranged pre-placement training programme from industry people	0.910
Soft skill training by experts has been introduced as inbound course curriculum.	0.910
The institute have arranged short term add on courses in the specialized area.	0.776
Student has been allotted good industries for their project work which help them to create access for placement opportunity in the similar type of industry.	0.675
The institutes has updated course curriculum commensurate with the industry requirements	0.723

Table – V Z and P value for Placement Expectation of students

S. No	Description of Expectations	Mean	Z - Value	P - Value	Result of test
1	Expectation of arrangement for pre placement training from industry people	.86	2.1267	0.033	Fail to accept the null hypothesis (<i>Expectation not fulfilled</i>)
	Expectation of arrangement for pre placement training from industry people full filled.	.64			
2	Expectation of arrangement for frequent soft skill training by professionals from industry	.61	1.8145	0.0695	Fail to reject the null hypothesis (<i>Expectation fulfilled</i>)
	Expectation of arrangement of frequent soft skill training by professionals from industry full filled	.69			
3	Expectation of add on courses to support the placement activities	.78	1.4757	0.14	Fail to reject the null hypothesis (<i>Expectation fulfilled</i>)
	Expectation of add on courses to support the placement activities full filled	.86			
4	Expectation of Project work in a reputed industry	.90	3.3893	0.006	Fail to accept the null hypothesis (<i>Expectation not fulfilled</i>)
	Expectation of project work in a reputed industry full filled	.70			
5	Expectation of updated and latest course curriculum as per industry requirement	.72	2.1008	0.0356	Fail to accept the null hypothesis (<i>Expectation not fulfilled</i>)
	Expectation of updated and latest course curriculum as per	.58			
	industry requirements full filled				

Source: Researcher's Analysis





A Study on Impact of Climate Change on Indian Business Economy

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ABSTRACT

Business is mostly dependent on the nature around us. Earth, being our home is habitual to all the economic and non economic activities of human beings. Our mother earth is continuously facing climate related crisis like inadequate rainfall mainly monsoons, severe heat & temperature, floods, draught and rise in the sea levels, the overall impact on economic environment is severe. As the Climate change is severely impacting the sustainability of life, livelihood and the ecosystem, the economists across the world are honing their emphasis on mitigating such risks. India is already among the top few growing economies which are vulnerable to the risk of climate change activities. We are already suffering the adverse impact of climate change in many parts of our country. This paper aims to explore the multifaceted effects of climate change on various sectors of the Indian economy, with a particular focus on its impact on markets. Climate change poses significant challenges to the Indian market dynamics, affecting agriculture, water resources, infrastructure, and overall economic stability. However, it also creates opportunities for research and innovation, sustainable practices, and the emergence of new markets. This presentation delves into both the negative and positive aspects, providing insights into the adaptation strategies required for a resilient and sustainable future.

Keywords: climate change, business economy, sustainability, impact, economic stability.

INTRODUCTION

Human Carbon footprint is a biggest concern as dependence on natural resources mainly fossil fuels have increased. This human interaction is of biggest reason for climate change. As a biggest global concern, climate change is impacting not only environment, but almost all other important aspects like business, politics, society etc. The impact of change in climate is one among the very complex and controversial problem of the current century as it has





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harmful effects on most of our business economies. It has a major impact on the economy in the short and long run. It is advisable to all business economies to recognize and adopt methods to survive with existing and unpredictable future impacts of climate change so that they can make the most of the current opportunities. This adaptation by the current business sector is not a formalized and generalized process. A few proactive futuristic companies have started to inculcate and include points related to protection of environment and climate in their policies were as most business managements have taken few more steps than complying with minimum expected standards and regulations prescribed by their government.

Objectives

1. To strengthen the knowledge on development of effective policies and regulations to mitigate the impact
2. To study the economic consequences of climate change in Indian business.
3. To study the long term implications of climate change in Indian business

METHODOLOGY

This paper is completely prepared based on secondary data available in website

REVIEW OF LITERATURE

1. Anita Fuchs, Eric Strobl and Preeya Mohan in their paper 'Climate change awareness and mitigation practices in small and medium-sized enterprises' (February 2023 Business and Society Review 128(425):1-23), throw light on how inculcate awareness on impact of climate change and to mitigation the action based on the factors which are either motivating or limiting the pro-environmental behaviour on the business environment.
2. Mr.Pratap Chandra Mandal in his research paper 'The New Marketing Realities and the Major Marketing Forces, Journal of Business Ecosystems'(March 2023 Journal of Business Ecosystems 4(1):1-14), writes that the main objective of their study is to analyze the different elements and aspects of social and physical environment and their influence on the business environment.
3. Manish Kumar Goyal and Shivam Singh, in their research 'Enhancing climate resilience in businesses: The role of artificial intelligence' (Journal of Cleaner Production, 2023 – Elsevier), focus on how the extreme change in weather condition mainly due to climate change in the last few decades has caused massive threat to all the sectors on economy all over the world.

Notable impacts of climate change on Indian business as per the survey

Climate change can have significant impacts on businesses, both directly and indirectly. Let's delve into each category:

Direct Impacts

1. **Physical Damage:** Businesses may face direct physical damage to their assets, infrastructure, or operations due to severe weather and environmental changes like floods, hurricanes, wildfires and storms. This can cause property destruction, equipment damage, and disruption of operations.
2. **Forced Closures:** Extreme weather events or environmental hazards may force businesses to temporarily or permanently shut down their operations, leading to financial losses and potential long-term impacts on viability.
3. **Increased Operational Costs:** Businesses may face increased costs for repairs, insurance premiums, and infrastructure upgrades to adapt to changing climate conditions or comply with new regulations aimed at mitigating climate risks.





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Indirect Impacts

1. **Supply Chain Disruptions:** Climate-related events can disrupt the availability or delivery of essential goods and services, impacting production schedules, inventory levels, and overall business operations. For example, droughts may lead to shortages of raw materials or agricultural products, while extreme weather events can disrupt transportation networks.
2. **Market Demand Changes:** Changing consumer preferences and behaviors in response to climate change can influence market demand of certain products or services. Businesses will have to adapt or develop new products to meet evolving customer needs and expectations.
3. **Financial Losses:** Businesses may experience financial losses indirectly through reduced revenue, increased costs, or decreased market value due to climate-related factors such as regulatory changes, reputational damage, or legal liabilities.
4. **Reputation and Brand Image:** Business environments may have to suffer reputational damage or loss of consumer trust if they are assumed as contributing to or exacerbating climate change through unsustainable practices or inadequate response to environmental risks. This can impact customer loyalty, investor confidence, and overall brand value.
5. **Policy and Regulatory Risks:** Businesses may face regulatory scrutiny or policy changes related to climate change mitigation and adaptation efforts, such as carbon pricing, emissions trading schemes, or renewable energy mandates. If the business does not comply with environmental regulations may result in fines, penalties, or legal action, posing additional financial and operational risks.

Expected Cost of Climate Crisis

In a situation of nonexistence of positive climate change to moderate and mitigate the effects, the Indian business economies may tremendously lose trillions(in turnover)in the forthcoming years. A research report by Deloitte specifies that if Indian industry and business sectors doesn't move towards low-emission fuels and reduce its dependence on fossil fuels, its industries and businesses could lose around \$35 trillion across various sectors by 2070. The total damage could be as high as 12.7% of India's GDP. As per the above report by Deloitte Economics institute - Climate model, no proper action by the government and business agencies on climate change may lead to reduction in India's economic and business potential by 5.5% per year on average over the next 50 years. The impacts of climate change on businesses can be multifaceted and complex, affecting various aspects of operations, financial performance, and strategic decision-making. Effective risk management and adaptation strategies are essential for businesses to mitigate these impacts and seize opportunities for sustainable growth in a changing climate. Researches by Reserve bank of India and other economic organizations are stressing a lot strategies to reduce the damages caused by climate change on our economy. If we don't initiate any positive steps towards environmental and climate change and to moderate and mitigate the negative effect of climate change, our business economy may have to face losses in the upcoming decades. If we start reducing the emission of green house gasses, we will be minimizing the carbon intensity into our environment.

In the process of becoming a fastest growing global economy, it is crucial to understand that it is not just our FDI and our domestic investments but our steps in aligning our ambitions with positive climate choices decides our drive towards economic growth. A study report by Deloitte says that if India becomes successful in leveraging its full potential in the process of decarbonization, then it would lead to a GDP growth of 8.5% by 2070, and about a \$4 trillion (in profit) gain in business output. India is currently taking few right steps towards positive climate change. This move has greatly increased the confidence to tackle the effects of climate change. Some of positive steps towards include Reliance Industries joining hands with an US-based Chart Industries to commercialize hydrogen and boost hydrogen production. On 2023 August 15, our Prime Minister, Mr. Narendra Modi announced a National Hydrogen Energy Mission as an initiative to reduce carbon emissions. Some notable Industries may also be at risk due to the climate change. The impact of climate change will be mostly on the labour and physical capital all business and industrial sectors. But the major hit might be for service sector, retail sector, manufacturing industry, construction sector and conventional energy industry. These major industries actually contribute towards almost 75 to 80% of our GDP.





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Notable solutions for these problems as recommended by the global economists

The impact of climate change on Indian businesses can be significant, affecting various sectors such as agriculture, manufacturing, energy, tourism, and infrastructure. Here are some solutions that Indian businesses can adopt to mitigate the impact of climate change:

Investment on Renewable Energy

Shifting to renewable energy resources such as solar energy, wind energy, and hydro energy can help reduce the greenhouse gas emissions and reliance on fossil fuels. Indian businesses can invest in onsite renewable energy generation or purchase renewable energy from third-party suppliers.

Implement energy efficiency measures

Improving energy efficiency in operations, buildings, and manufacturing processes can reduce energy consumption and greenhouse gas emissions while also lowering operating costs. This could involve upgrading equipment, optimizing processes, and adopting energy-efficient technologies.

Adopt sustainable practices

Businesses can implement sustainable practices across their operations, such as minimizing waste generation, promoting recycling and reuse, and using eco-friendly materials and packaging. Sustainable supply chain management can also be prioritized, ensuring suppliers adhere to environmentally responsible practices.

Water Conservation

Given India's water scarcity challenges exacerbated by climate change, businesses can implement water conservation measures to reduce consumption and optimize water usage in operations. This could involve implementing water-efficient technologies, recycling wastewater, and promoting rainwater harvesting.

Climate-Resilient Agriculture

For businesses involved in agriculture or reliant on agricultural inputs, adopting climate-resilient farming practices can mitigate risks associated with climate change-induced weather variability. This includes promoting drought-resistant crops, efficient irrigation techniques, and soil conservation methods.

Risk Management and Adaptative Strategies

Businesses should assess their vulnerability to climate change risks and develop appropriate risk management and adaptation strategies. This could involve investing in infrastructure that can withstand extreme weather events, diversifying supply chains to reduce dependency on vulnerable regions, and incorporating climate risk into business planning and decision-making processes.

Collaboration and Advocacy

Collaboration with government agencies, industry peers, and civil society organizations can amplify efforts to address climate change challenges. Businesses can advocate for supportive policies and regulations that incentivize climate-friendly practices, such as carbon pricing, subsidies for renewable energy, and incentives for energy efficiency investments.

Employee Engagement and Education

Engaging employees in sustainability initiatives and providing education and training on climate change can foster a culture of environmental responsibility within the organization. Employees can contribute ideas, participate in energy-saving initiatives, and champion sustainability efforts both at work and in their personal lives.



**Chandrika****Green Innovation and Technology Adoption**

Investing in research and development of green technologies and innovations can not only help businesses reduce their environmental footprint but also create new revenue streams and competitive advantages. This could involve developing innovative products, services, or business models that promote sustainability.

Transparency and Reporting

Businesses should transparently communicate their environmental performance, including their efforts to mitigate climate change impacts, to stakeholders such as investors, customers, and regulators. Reporting on carbon emissions, energy usage, and sustainability initiatives can build trust and credibility while encouraging continuous improvement.

Findings and suggestions

Impact of climate change is on all the three sectors of the economy. Whether your business is small or big, national or multi-national the impact is always on huge. It is in our hands that we as an individual or a firm or an enterprise, the steps we take to face and handle the climate change issues is very important. Here are few suggestions from the study:

1. Government and Private sector together have to ensure they take the right step in preventing the damage being caused to the environment which is leading to adverse climate change
2. Indian businesses can play a crucial role in mitigating the impact of climate change while also seizing opportunities for innovation, resilience, and sustainable growth.
3. Educating consumers about the environmental impact of the products and services can encourage more sustainable consumption patterns and drive demand for eco-friendly alternatives.
4. Indian business agencies can engage with government agencies NGOs and other business to advocate for stronger environmental policies and collaborate on sustainability initiatives can amplify the impact of individual efforts
5. Implementing waste reduction and recycling programme within operations can minimize waste sent to landfills and decreases the overall environmental footprints of the business.

CONCLUSION

Climate change is one of the greatest of challenge faced by the mankind. Human beings have changed the complete bonding of the ecosystems of the atmosphere, land, oceans etc with shocking consequences and effects. Many business enterprises are epicenters to these challenge. These epicenters are the main elements which encourage the increase in greenhouse gas emissions. They also provide basic platform to find out new innovative methods to decarbonize our economic systems. In this paper, we can learn the ways climate change influences our business and ways and methods our country can respond to curtail the impacts of climate change. It is not only the duty of the government to bring in regulations to regulate the climate change, but the ownership falls on all our shoulders to take small steps to protect our environment. Weather it is our own house or our business or the industry, it is all our responsibility to sustain the warmth climate for our future generation.

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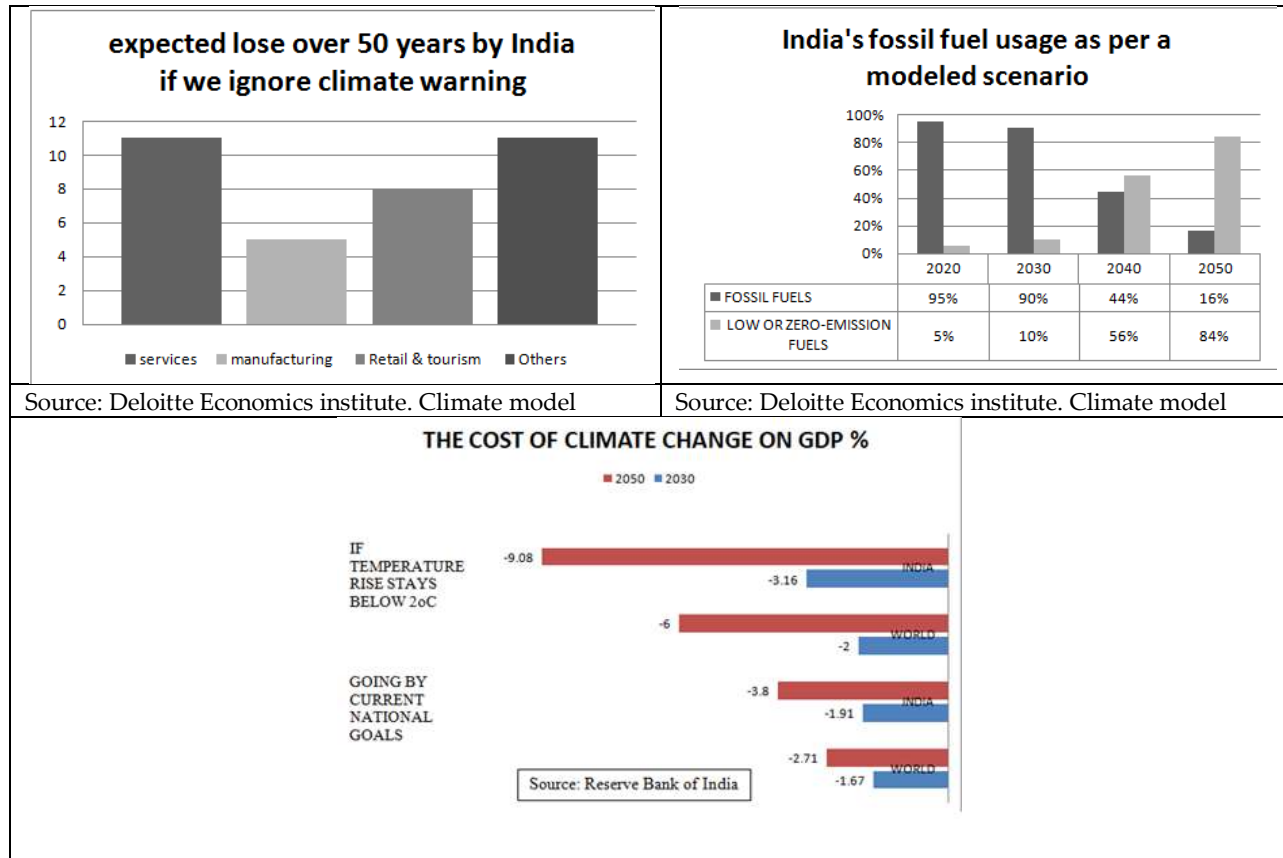
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RESEARCH ARTICLE

The Impact of Digital Marketing on Youths' Purchase Intention and Engagement

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ABSTRACT

The great majority of enterprises and companies today undoubtedly use digital marketing is one of their primary marketing techniques. The resources provided by this technique, which transcends geographic boundaries, allow them to market their goods to a far wider audience. Additionally, because the information is tailored to the preferences of the users, it can help establish stronger ties with the users. The research examined how digital marketing influences teenagers' purchasing intentions, specifically focusing on their online buying decisions. Utilizing an exploratory research design, both primary and secondary data sources were employed, including structured questionnaires and literature from various sources. The study targeted teenagers who favor online purchasing, with a sample size of 145 respondents selected randomly. The findings indicated a noteworthy influence of digital marketing on teenagers' purchase intentions, particularly highlighting social media marketing as the preferred channel for online purchasing decisions

Keywords: Digital Marketing, Teenagers, Purchase Intention, Customer Engagement.

INTRODUCTION

The world is always changing, and right now it's more complicated than ever. Technology has made everything easily available to people. This applies to the marketing industry too. Getting information is really easy now. The way things are made leads to new trends. Everywhere that digital platform are crucial to marketing, there is now more rivalry for new products and marketing breakthroughs than ever before. Outbound marketing strategies had been mostly superseded by inbound marketing strategies. Some claim that digital marketing is the most successful





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marketing method. They were giving organizations the devices they expected to work really and imaginatively in the advanced commercial center. Despite area, advertisers could discuss straightforwardly with possible clients through advanced channels. The utilization of advanced media in promoting has consistently gone under more prominent examination. The conceivable outcomes are limitless when every one of the advances that are accessible and offered today are utilized to their maximum capacity. Advertisers are all the more habitually involving these channels for an expansive scope of goals, making top to bottom information and measurements on each count, checking the outcome of their endeavors, and in any event, gauging and processing the probability that their utilization of it will help them out. While others center around offering better support to a current market, others use them to draw in new associations. Apparently while grasping the effect of different computerized media on young people buying, advanced promoting channels and ideas are applied freely and functionally. The possibilities for new social strategies from the market are soon yet to be found or created by advanced advertising, which is as of now accessible, is continually developing, and makes a point to stay in contact with us people until the end of time.

LITERATURE REVIEW

Omkar Dastane (2020), the impact of digital marketing on the purchasing behavior of online shoppers in Malaysia was investigated. The study also looked at how customer relationship management (CRM) influences the relationship between digital marketing and online purchase intent. The findings showed that digital marketing significantly influences online purchase intent, while CRM had a minor effect. This study contributes by creating a model to assess the impact of digital marketing on online shopping behavior in Malaysia. The paper also discusses recommendations, limitations, and future research opportunities. Alok Kumar Pal and Dr. Bharti Shukla's study in (2020) examines how customer purchasing habits are changing rapidly in consumer-centric market environments. The study focuses on the impact of digital marketing on buyer behavior due to the significance of youth purchasing behavior. It explores how young people engage with digital media in their everyday lives. Qureshi Riyaz Ahmed and others(2019) found that internet usage is growing, especially among young people who have grown up with computers, the internet, and mobile technology. These technologies significantly impact how young people spend their time and influence their buying habits. The study suggests that companies should connect with young consumers through the internet due to its strong influence on their lives and market trends.

RESEARCH METHODOLOGY

This study is under taken for 145 participants from Bangalore North city as its sample size. The main focus of the questionnaire was to collect information from the respondents about their attitudes towards online shopping and the behavior of young people.

SAMPLE DESIGN OF THE STUDY

A sample of data from young people in Bangalore North City has been obtained. Data has been gathered from a variety of locations in the Bangalore North Region. This area's geographic region was the focus of a lot of data. Additionally, secondary data on consumer attitudes toward digital marketing has been gathered through research reports, journals, and other sources.

RESEARCH OBJECTIVES

1. To evaluate how digital marketing channels influence the purchasing choices of young people.
2. To know the impact of tailored advertising and focused marketing on young people's buying intentions.
3. To understand the connection between young people's participation with digital marketing content and their propensity to make a purchase and provide suggestions.



**Roopa****DATA ANALYSIS****Age-Wise Respondents**

Figure indicates that the age group 18–19 had the highest number of respondents, falling between the male (48) and female (33), and the age group 20–21 between the male (35) and the female (23). The age group 23–24 had the lowest number of respondents, falling between the male (1) and the female (1). This indicates that among Bangalore North city's age group of 21 to 26, the influence of young behavior on digital marketing is fairly significant.

Gender wise Respondents

A reflection of the study respondents, comprising 87 male and 58 female respondents. This indicates that 40 percent of young women and 60 percent of males have engaged in digital marketing to purchase products

Educational Qualification of Respondents

Figure demonstrates that undergraduate students' buying behavior related to digital marketing is significantly higher (112) than that of bachelor's degree holders (26), and master's degree holders (7). This indicates that the effects of digital marketing on teenage students are greatest, and that the behavior of students is more influenced by digital marketing. In contrast to students pursuing higher education and those holding a bachelor's degree.

Digital Marketing Awareness among Respondents

According to a table and figure analysis, respondents' awareness of digital marketing varied between males (83) and females (50). This represents 57% and 34% of all male and female respondents who are aware of digital media. However, between male 4 (3%) and female 8 (5%), there are individuals who do not know about digital. This indicates that a large percentage of respondents—133 or 92% of them—have a high level of digital awareness, compared to just 8% of respondents—12 or less—who do not. The respondents in Bangalore North city appear to have a very high level of awareness regarding digital marketing.

Usage of social media platform

Males (83) and females (50) respondents' awareness of digital marketing varied, according to a table and figure study. This indicates that 34% and 57% of all respondents—male and female—are aware of digital media. But there are those who are unaware of digital, with 4 men (3%) and 8 women (5%). This shows that 133 respondents, or 92% of the total, have a high degree of digital awareness, whereas just 8% of the respondents, or 12 or less, do not. It seems that Bangalore North city respondents are very knowledgeable about digital marketing.

Sources of discovering digital marketing content

A table and figure study shows that social media (49.8%), online reviews (15.17), and adverts (22.7) are the main ways that respondents find the information. In contrast, search engines (9.6%), email (1.36%), and referrals from influencers (1.36%) are examples of alternative sources.

Factors affecting Buying Decisions of Respondents

Between male and female respondents, the following factors influence their use of digital marketing: discounts (37%), product reviews (25%), ease of purchase (13%), brand reputation (10%), satisfaction guarantees (6%), ad creativity (4%), free trial samples (2%), and, in that order, website trustworthiness, personalization, and limited-time offers (1%). Teenagers seem to be using digital marketing for a variety of reasons, including product reviews, discounts, simplicity of purchase, and brand reputation, among others, in order to satisfy their usage requirements.

Factors influencing Customer Engagement

In comparison to other aspects taken into consideration in the study, a figure study reveals that videos (34%), social media postings (18%), blogs and articles (15%), and social media stories (11%) are the main components that engage customers and influence their purchase decision.





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Teenagers' participation with digital marketing content

The survey results indicate a generally positive influence of digital marketing on consumers, with a majority agreeing (48%) that it helps in searching for the right products(40%), increases interest in purchasing through social media advertisements(38%), and provides quality information during online shopping(28%). Additionally, the findings highlight a high likelihood of satisfaction after making a purchase through digital platforms, showcasing the effectiveness of digital marketing in shaping consumer behavior and fostering brand engagement.

CONCLUSION

Digital media enables online shopping, providing a convenient way for youths to browse products, compare prices, and make purchases from the comfort of their homes. Apps and websites often offer features like live chat support, enhancing customer service and engagement. Quick responses to queries can positively impact the decision-making process. Limited-time offers, flash sales, and exclusive online events capitalize on the FOMO culture, driving impulsive purchases among youths who fear missing out on a great deal. Social media platforms often create hype around these events, encouraging youths to engage with the brand and participate in the limited-time offers. In conclusion, digital media plays a pivotal role in shaping youths' purchase intention and customer engagement. Through targeted marketing, interactive content, social influence, and personalized experiences, brands can effectively capture the attention and loyalty of young consumers in the digital age.

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Table-1 Usage of social media platform

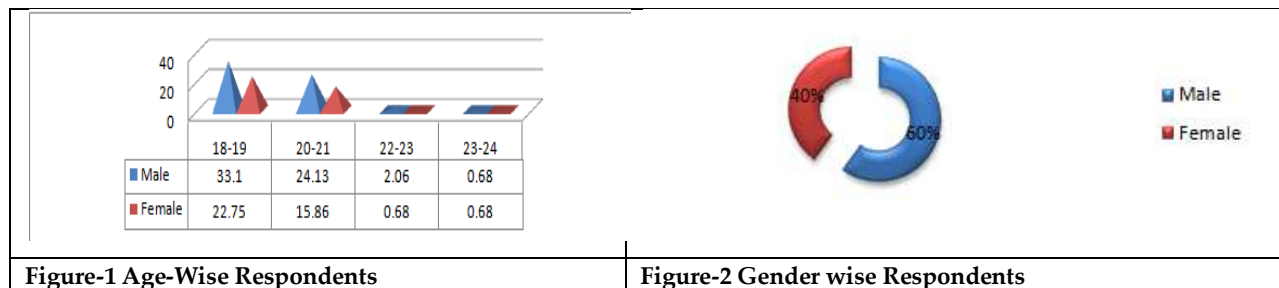
Sl.No	Usage of social media platform	Male	%	Female	%	Total	%
1	Constantly	5	3.4	12	8.2	17	12
2	Daily	78	54	40	27	118	81
3	Weekly	2	1.3	1	0.6	3	2
4	Monthly	0	-	1	0.6	1	0.6
5	Rarely	2	1.3	3	2.6	5	2.8
6	Never	0	-	1	0.6	1	0.6
	Total	87	60	58	40	145	100

Source: Primary Data

Table-2 Sources of discovering digital marketing content

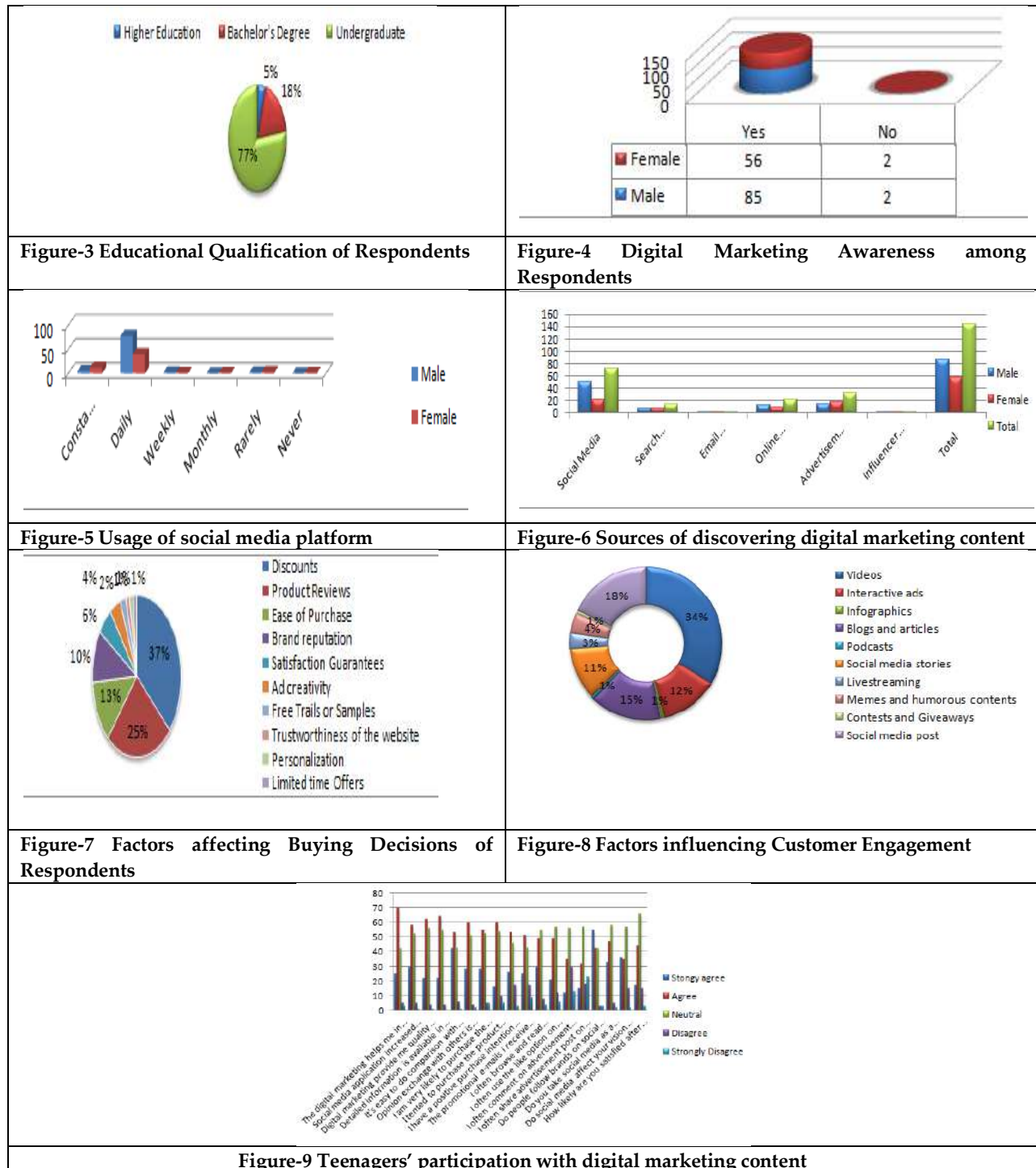
Sl.No	Sources of discovering digital marketing content	Male	%	Female	%	Total	%
1	Social Media	50	34.6	22	15.1	72	49.81
2	Search Engine	7	4.8	7	4.82	14	9.6
3	Email Subscriptions	1	0.68	1	0.68	2	1.36
4	Online Reviews	13	8.9	9	6.08	22	15.17
5	Advertisement	15	10.34	18	12.4	33	22.7
6	Influencer recommendations	1	0.6	1	0.68	2	1.36
	Total	87	60	58	40	145	100

Source: Primary Data





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RESEARCH ARTICLE

Feminism and Modernity as an Evolving Culture in the Selected Work of Chetan Bhagat (One Indian Girl)

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ABSTRACT

This paper tries to connect different perception of culture and cultural narratives with the reference of protagonist in the novel one Indian girl by Chetan Bhagat. Radhika, protagonist will be spoken much rather than the writer but giving the minimal recognition. Cultural narratives will be studied in a regular social constructed ideology but this paper tries to put forth new cultural narratives with the backup of Williams cultural analysis theory. The protagonist of the novel introduces herself as she is Radhika Mehta and she would be getting married that week, and she works at Goldman Sachs, an investment bank. She Thanks the readers for reading her story at the same time she warns them too. She says that readers may not like her too much. The reason she gives for dislike is One, she makes a lot of money, Two, she has an opinion on everything, Three, she would have had a boyfriend before, maybe two. If she was a guy, readers would be okay with all of that. Just because she was a girl, those three things don't make her likeable. These are the lines which a reader can see on the back cover page of the book where Radhika starts her story with the note of what society thinks, and the scenarios she has experienced which is like breaking the stereotypical structure of the society. And it is a direct question to the readers as well as society. She says that she may not be liked by everyone or the readers for being the woman who earns a lot of money. To prove feminism and modernity as an evolving culture. To make the readers understand the characters of the novel from both feminism and modernist perspective. The main objective of the paper is to prove how modernity and feminism is the base of evolving culture and the primary cause to prevention of harassment against women.

Keywords: FEMINISM, MODERNITY, STEREOTYPE, CULTURE.



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INTRODUCTION

This paper is an attempt to take feminism and modernity as an evolving culture in the contemporary world like any other cultural norms and beliefs. Every creature which takes birth on this earth has to belong to one or the other group or community. Even a lion, a king of jungle has to live with its own community rather it cannot live with other communities like rabbit or dears. In the same way human society has been divided on the basis of religion and region where he or she takes birth in the respective community has to join the community and should live on. Here comes the culture one has to follow after being in the community. This culture varies from region to region and religion to religion and at the same time human to human how he or she receives the culture. According to Mathew Arnold Culture is fresh stream, even though generation dies culture doesn't die culture is study of perfection. It is inner voice and inward condition of mind and spirit. It takes near to the beauty of culture, beauty and grace should be seen in everything. He says moral values has been shifted from the old culture. He is proving railroad, mining of coal is wrong rather love, interest and admiration builds up an individual as cultured. He takes example of cricket and football as cricket is the upper class game where as football is lower class game. The greatness lies in the inward manifestation. So in this way culture has developed from just belief, custom, behavior into way of studies and way of thinking. in this manner culture has grown into cultural studies and it has gain its importance in literature.

A cultural theorist Raymond Williams in his book the long revolution in 1961 he speaks about the social change nothing but the revolution, it also includes revolution in the area of industry and democracy. To speak about the analysis of culture Williams has divided the culture into three types according to his own ideology and philosophy. The initial type is 'ideal' where the meaning is being inspiration and providing encouragement and being example to others. So according to Williams the ideal culture is a process where it leads the humanity into perfection. So the ideal culture should make the man perfect and it should create the way for him/her to attain perfection. Next he says culture as documentary, which is like body of intellectual and imaginative work. So the the imaginative work sets standard in its body, means the ideology and the thought process of the work. It may be also given different opinion through criticism. It not the condition that all the thought process or criticism should be one and the same, it can be varied from person to person and from environment to environment. Finally, third there is the social definition of culture, in which culture is a description of a particular way of life, which expresses certain meanings and values not only in art and learning but also in institutions and ordinary behavior. The analysis of culture, from such a definition, is the clarification of the meanings and values implicit and explicit in a particular way of life, a particular culture. Hence this paper tries to connect different perception of culture and cultural narratives with the reference of protagonist in the novel one Indian girl by ChetanBhagat. Radhika, protagonist will be spoken much rather than the writer but giving the minimal recognition. Cultural narratives will be studied in a regular social constructed ideology but this paper tries to put forth new cultural narratives with the backup of Williams cultural analysis theory.

METHODOLOGY

Qualitative ethnographic research method is used here for the research where Radhika's character will be observed in depth and analyzed in feminism and modernity cultural narratives.

Objective

To prove feminism and modernity as an evolving culture.

To make the readers understand the characters of the novel from both feminism and modernist perspective.

LITERATURE REVIEW

Breaking Gender Stereotype: Women of India in Chetan Bhagat's One Indian Girl – a Study (Ragupathi Ramasamy-2019) In this research paper an attempt had been made to show how cyber feminism in One Indian Girl



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has great relevance to the understanding and interpretation of gender studies. It was a fact that all men and women all over the world looked at women from their point of view but here in the novel *One Indian Girl* Chetan Bhagat in his acknowledgements thanks all the women he met and interviewed. It seemed that he has expressed based on the information collected. Chetan Bhagat made his relentless attempt to express both feminism and patriarchal society but he fails to understand matriarchal society where women always decide.

“ONE INDIAN GIRL”: A WOMAN’S JOURNEY TOWARDS TRUE SELF-DEPENDENCE (A.S. ASHAKIRAN-2017) This paper attempts a feminist reading of Chetan Bhagat’s latest novel – “One Indian Girl”. While the narration traces a woman’s journey towards confidence and self-respect, it also exposes the hypocrisy of the Indian male and the sexist attitudes ingrained into cultures.

Chetan Bhagat’s novel One Indian Girl ----A Portrayal of a modern Indian Girl ‘s change in attitude towards life (Mrs. K. Umakiran 2020). The overall summary of the novel is being shown in this paper with the touch of modern girl and feminism. All the referred and found papers or journals speak about the novel in feminist perspective or modern girl perspective individually. But this paper is trying to give a touch of cultural studies with feminist point and modernity point together in one paper to prove that feminism and modernity is not just way of thought but also evolving as new culture, to support the thought process cultural and modernism theorists like Raymond Williams, Mathew Arnolds ideologies have been included.

FEMINISM as STRUCTURE OF FEELING

The structure of feeling refers to different ways of thinking vying to emerge at any one time in history. It appears in the gap between the official discourse of policy and regulations, the popular response to official discourse and its appropriation in literary and other cultural texts. This paper tries to bring out the connection between the emergence of feminism with that of structure of feeling by Raymond Williams. Initially the status of women before even connecting to the word feminism was very poor and pathetic. Women suffered under the social evils like gender inequality, patriarchal society and domestic violence. Especially speaking with Indian context history speaks a lot about women exploitation. For example, Sati and Jauhar system where women used this system to protect themselves from the social evil exceptional to any of the religion. Even during the captivity male targeted the women, where they were sexually abused. As the wheel of the history spins women exploitation continues under the name of domestic violence. Some accepted and some did not revolt but accepted and moved on with their life keeping away all their interest, likes and dislikes. To speak the time span of post-independence, exploitation of women had reduced gradually but at the same time great opportunities were created for women specially in the field of politics, education, employment and so on though the exploitation of women continued in one or the other way. For example, in the work place and education spaces discrimination of women on the name of gender could be seen.

In the beginning woman was not allowed to step out of the house, later she was allowed to come out but created unsecured environment around her. But after that many constitutional articles and policies were created to create secure environment for the working ladies. Through lot of awareness, experiences and guidance women were able to come out and fly high. Today we can see woman in every field and everywhere she has created her impression with strong acknowledgement in the work assigned or creating her own empire of her interest. Still there was some kind of insecure feeling which was untold but gone through, as the day passed all those insecurities and unpleasant experiences came out in the name of MEE TOO MOVEMENT. This rally or movement threw light on the unpleasant experiences of women of all the working field irrespective of caste, religion and region. *One Indian girl*, the novel which was taken as original text speaks about the protagonist RADHIKA, an Indian girl who was scholar in studies and secured a job in great investment bank. A perfect feminist actually a perfect human being who believes in gender equality and tries to change the stereotype but fails in succeeding in bringing her ideology into action. The protagonist of the novel introduces herself as she is Radhika Mehta and she would be getting married that week, and she works at Goldman Sachs, an investment bank. She Thanks the readers for reading her story at the same time she warns them too. She says that readers may not like her too much. The reason she gives for dislike is One, she makes a lot of money, Two, she has an opinion on everything, Three, she would have had a boyfriend before, maybe two. If



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she was a guy, readers would be okay with all of that. Just because she was a girl, those three things don't make her likeable. These are the lines which a reader can see on the back cover page of the book where Radhika starts her story with the note of what society thinks, and the scenarios she has experienced which is like breaking the stereotypical structure of the society. And it is a direct question to the readers as well as society. She says that she may not be liked by everyone or the readers for being the woman who earns a lot of money. As spoken before, women were given educational opportunities and financial independence much later after the independence, Radhika can be an example because she was the girl who never got entertained like her elder sister but she was an intelligent academican and cracked all her competitive examination and she was placed in investment bank called Goldman Sachs. She has reached out to the society as a successful independent woman. being financially independent for a woman means a lot, it creates self-confidence, self-motivated and she can prove herself to the world. Financial independency can make her a person, whom she wants to be, and she can explore the things which could have been difficult for her because it creates mobility. Radhika was such person, who could move out of her sentimentally attached place and find her new beginning without any hesitation, this woman was created through financial independence. The first and foremost ideology of feminism is this, being financially independent. Next speaking of the third reason why she couldn't have been liked by the readers is she had a boyfriend before. Okay may be two- this can be seen as giving importance to her own likes and dislikes. As we see Radhika, throughout the novel she acts as a common girl who gets attracted towards her opposite gender and wishes of common girl who wants to love and select her life partner and to be loved in return by her life partner.

As Radhika moves on to America she meets a Bengali guy by name Debashish Sen. Radhika and Debashish were good friends in the initial days as the day went on they developed love relationship with each other. This relationship made them to feel as they are one like Adam and eve when they were created. In this sex relationship she asks for the gesture which gives her satisfaction and pleasure as Debashish uses word called 'finished' as synonym for being satisfied. So the sense of feminism has given chance even for women to complete her sexual needs and to ask for that without any hesitation. Next to speak with her third opinion she had a boyfriend, may be two. If it was a boy the readers would be ok. So this can be seen in a feminist perspective where getting into relationship and moving out of it is common for everybody because only after getting into relationship the strengths and weaknesses could be experienced from both the end. In this context there can be no gender discrimination because it's the life of both man and woman. since from our ages we have heard that a girl should be loyal to a man and there is no necessity that man should be always loyal to woman. feminism has emerged on the basis of this, where both the gender has to get equal opportunity to say yes or no. Radhika who was ready to quit her job for the sake of Debashish, later decided to move on after realizing that he is not loyal to her. So that's where feministic seal stamps on her. It's not the attitude or being feministic in all the scenarios but trying to protect her self-esteem and self-respect. So herself questions, that if this was done by a guy it would have been ok for the readers, just because all this was done by a lady it's not that it shouldn't be questioned or assassination shouldn't be done on the girl. So in this way Radhika's character throughout the novel reaches out to the readers as feminist and as well as a lady who dares to take her own decision on her life and speaks about the gender equality.

MODERNITY AS AN EVOLVING CULTURE.

Modernity has evolved as the new culture in the contemporary world. The origin of the modernity lies in the criticism of any read or given work. The meaning of the criticism is not only the negative shade but also it creates the new beginning. Criticism questions the logical reasoning and practicality. Hence the constructed ideology and stereotype gets disturbed and shakes its foundation. The new architecture, buildings and modern constructions are not only the result of modernism but it should be reflected in the way of life and way of ones thought. Modernity is not the term which should be indicated by wearing the branded or styled clothes but one should wear the thoughts and principles of modernity which creates new beginning and makes path for the era which provides equal opportunity for everyone irrespective of caste, gender, religion and region. Modernity is a term of art used in the humanities and social sciences to designate both a historical period as well as the ensemble of particular socio-cultural norms, attitudes and practices that arose in post-medieval Europe and have developed since, in various ways and at various times, around the world. While it includes a wide range of interrelated historical process and



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cultural phenomena, it can also refer to the subjective or existential experience of the conditions they produce and their ongoing impact on human culture, institutions and politics. Realism associated with modernity. Realism was a reaction against the romanticism of the 18th and 19th century. The style of art and literature that is used to depict the physical world and human life with scientific objectivity and detached observation. The realist movement in literature portrayed the hypocrisy, brutality and the dullness that underlay bourgeois life. Modernize, modernism and modernist used by Jane Austen. Modernism is a cultural movement. Each one is modern in his/her own way but nowhere its clear. Modernity and modernism are not the same. Modernity has lot to do with attitude in social relationship. It elevates the individual achievement and accountability in the public life, adherence to universal norms. Sexual harassment, dowry death, violence in public all these happen in modernity. But actually they are the carry overs of past tradition. Modernity is the process which comes in baby step and it is long process to change the past carry overs. And it is like, one has to experience advantages and disadvantages from their birth. One such example is, the protagonist Radhika (one Indian girl).

Radhika had to undergo the color discrimination during her school days and her sister was admired for her color. Which is just undergoing social discrimination even in the metropolitan cities, which is known for modernity. On the other hand, Radhika and her elder sister was able follow their own interest. Radhika followed her studies and academic, career success and her elder sister studied on an average scale having idea in her mind to set up her family life. The other instance is Radhika was able to move to America, Hong Kong and then to London regarding her job role in the short period of time and as well as like her interest. So modernity made her to change her job role and to move on from one environment to another. Modern thoughts and experiences made her to take her own decisions on her life, may be while choosing Debashish or Neel Gupta or Brijesh as well as calling off her marriage on the wedding day. So the modern thought has made Radhika to take important decisions in her life. Even Debashish was able to commute to the place where Radhika destination wedding was arranged so easily, travelling by direct and connecting flights. The concept destination wedding itself gives the idea of modernity. The generation has grown so far and advanced. Even in the monetary aspect Radhika earned so much so that it was all of the above, a great salary. Like olden days' transportation is not that difficult. We can contact people easily even through electronic items like email, WhatsApp, Instagram etc. modernity is not just being modern physically but it also includes thought and taking it to everywhere. Referring to the novel it was done through food. Because even in America Radhika and Debashish was able to find Rasagulla and Parathas (pp. 45,46) which shows the modern technology, transportation has incorporated in it everything including food. Because food plays a major role in one's life in foreign countries, it gives touch of tradition, culture and sense of belongings.

CONCLUSION

This objective of the paper has been proved to the maximum extent because it has impact feminism and modernity as an emerging culture. To speak comparatively feminism in the initial days was seen only as the movement but it is a revolution which created change in the thought process and way of living. Feminism in the contemporary era is not being just as thought process but its being the way of life. Feminism is not just the culture which has to be followed only by girls or woman but it also should be followed by men and it's been adopted by men also. In the context of novel Debashish who told Radhika is not a wife thing later on realized it. And it is evident from the character of Brijesh who supports Radhika in every way and treats her equally and gives equal attention to her emotions as well. To speak about modernity, many people have wrong consumption about modernity and modernism. Modernity is not just physical appearance or using modern electronic gadgets, but it is way of thinking and way of living including all the immaterial things. Modernity should create equal opportunity, equality irrespective of caste, creed and religion. Like feminism, modernity is not fully evolved as culture because it has its own loophole that it creates opinion on everything, people cannot handle stressful situation and will not be clear enough to choose what one wants. That's what happened with the character of Radhika, who had opinion on everything and calls off her marriage with unclear vision. But now modernity is growing as new culture, where it has its own time to be cultivated and to be a part of everyone's life.





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Competencies in Web 2.0 Skills of Library Information Science Professionals Working in Colleges in Northeast India

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ABSTRACT

This study examines the Web 2.0 skill capabilities of LIS professionals in Northeast India institutions to assess digital strengths and development possibilities. Given the transformative implications of Web 2.0 technologies on library services and digital engagement, these skills are crucial to enhancing them. This quantitative research surveyed 135 library and information science (LIS) professionals using a pre-designed questionnaire to assess their knowledge of Web 2.0 applications such as blogging, social networking, multimedia creation, collaboration platforms, and content curation. The findings demonstrate that LIS professionals are moderately to highly proficient in multimedia production and collaboration technologies, meaning they can create engaging digital content and collaborate successfully online. However, the poll reveals a considerable lack of social media skills, therefore professionals must improve this area. Analyzing skills across populations may reveal how years of experience and education affect Web 2.0 competence levels among LIS professionals. The research concludes with recommendations for library and information science (LIS) professionals, college administrators and policymakers emphasizing continual education, professional development, and deliberate training and technology investment. LIS personnel may enhance library services and user engagement in the digital era by bridging skill shortages and using Web 2.0 technology.

Keywords: Web 2.0 Skills, Library and Information Science, digital engagement, professional development, Northeast India.





INTRODUCTION

Web 2.0 technology have made library services more interactive, participatory, and user-centered than transactional. This transition stems from Web 2.0's emphasis on user interaction, social connection, and content sharing, describing here how new technologies have changed library services by facilitating engagement and cooperation. Due to Web 2.0 technology, libraries are increasingly dynamic, user-driven venues where users may actively create and share new information. Users may remark, trade, and produce information on blogs, wikis, and other social media sites. This interactive method fosters community by encouraging library users to collaborate. The emergence of online communities where users and library professionals may communicate in real time has made Instagram, Twitter, and Facebook crucial to library services. Libraries can promote their events and services, hold two-way discussions, and gather customer feedback on one platform, increasing user satisfaction and loyalty. These platforms also allow libraries to share success stories, encourage user contributions, and tell narratives, strengthening communities. Libraries may now create collaborative learning environments using Web 2.0 technologies.

Educational forums, wikis, and Google Docs provide cross-border cooperation, information exchange, and project management. This collaborative technique fosters information literacy and lifelong learning by enabling user-to-user knowledge generation and exchange. Libraries may customize resources and communications for users using Web 2.0. Personal book selections, user-curated collections, and customizable alert systems make the user experience more relevant and entertaining. Through users' behaviour and preference analysis, libraries may customize their services using Web 2.0 technologies to prioritizes users. Web 2.0 has altered reference services using chatbots, instant messaging, and video conferencing by libraries for real-time, interactive help. These tools allow library professionals to help users in ways that aren't feasible in a typical library, enhancing reference services' reach and convenience. Users get a more engaging and personalized experience because library professionals may give fast, personalized aid utilizing interactive reference services. Libraries are increasingly using crowd sourcing to enhance collections and services. User-generated material like photo tagging, document transcription, and community archive projects may provide libraries more perspectives and information. This increases library collection diversity and depth and encourages users' participation.

NEED FOR THE STUDY

Cultural, technological, and pedagogical factors make studying Web 2.0 capabilities among Northeast Indian LIS professionals particularly relevant. Due to its cultural, linguistic, and geographical diversity, Northeast India's higher education and library services are distinctive. Developing Web 2.0 skills in this area is important because: Due to its rugged and impassable geography, Northeast India is often isolated from mainstream advancements and resources. Remote access and connection made available by Web 2.0 technologies are tempting tools for solving these gaps. Researching and developing LIS professionals Web 2.0 skills may improve resource sharing, virtual collaboration, and digital library access. This helps overcome physical information barriers. As in other regions of India, North-Eastern colleges are increasingly using online learning platforms and digital resources to supplement classroom training. LIS professionals in Web 2.0 technologies may help with digital collection curation, e-learning platform support, and open educational resource creation. Their expertise may enhance classroom education by boosting online resources for instructors and students. There has been much improvement, yet Northeast India still lacks digital connectivity. Varying communities still have different internet and digital technology access. Web 2.0-savvy LIS professionals may help promote digital literacy and diversity. Workshops, online tutorials, and digital service access let students and the community fully participate in the digital world. This will aid digital connectivity. Libraries are essential to preserving and sharing Northeast India's rich culture. Web 2.0 allows libraries to digitize books, documents, and art efacts, increasing global access. Library professionals may lead digital archive and platform initiatives to conserve and promote local cultures, languages, and histories. Libraries may engage their communities and collaborate in new ways using Web 2.0 technologies. Anyone with library and information science skills may use blogs, social media, and other online platforms to promote the library's programmes, collections, and services to the public and students. They may also assist libraries, schools, and cultural organizations collaborate on



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projects and resources using Web 2.0 technology. Library and information science (LIS) professionals must constantly improve their skills, especially in Web 2.0 technologies, due to the fast growth of technology. To avoid colleges in Northeast India from falling behind in technological developments, which may be exacerbated by geographical and infrastructural barriers, library and information science professionals must be trained to exploit new technology. This improves customer service and prepares pupils for the digital economy. LIS professionals must learn and develop Web 2.0 abilities to maintain North Eastern colleges competitive and linked in the digital era. This will use technology to promote education, inclusiveness, cultural heritage, and connections. Libraries may become lively, engaging community, education, and research hubs in this rich and diverse region with this purpose in mind.

RESEARCH QUESTIONS

The scope and technique of a study are guided by the formulation of accurate and meaningful research questions. Following are a few of research questions that can serve as useful frameworks for this study, taking into account the aims and setting of evaluating Web 2.0 abilities among LIS professionals in North East Indian colleges:

Main Research Question

What is the level of Web 2.0 competencies among LIS professionals working in colleges in Northeast India?

Skill Assessment

Which specific Web 2.0 skills do LIS professionals in Northeast India's colleges possess, and at what proficiency levels?

Training and Development

What types of training or professional development opportunities have LIS professionals in these colleges undertaken to improve their Web 2.0 skills?

Application and Usage

How do LIS professionals in Northeast India's colleges apply Web 2.0 technologies in their library services and operations?

Barriers and Challenges

What are the main barriers and challenges that LIS professionals in these colleges face in acquiring and applying Web 2.0 skills?

Impact on Library Services

How do Web 2.0 skills among LIS professionals impact the quality and range of library services offered in colleges in Northeast India?

Support and Resources

What support and resources do LIS professionals in these colleges need to develop and utilize Web 2.0 skills effectively?

Future Perspectives

What are the perceptions of LIS professionals regarding the importance of Web 2.0 skills for the future of library services in colleges in Northeast India?

OBJECTIVES OF THE STUDY

1. To evaluate Northeast Indian college LIS professionals' Web 2.0 skills.
2. To identify training and professional development needs among LIS professionals.
3. To examine the Application of Web 2.0 in Library Services.
4. To understand barriers to effective Web 2.0 Skill Development and Application.
5. Evaluate the Impact of Web 2.0 Skills on Library Services offered by colleges in Northeast India.





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REVIEW OF LITERATURE

Web 2.0 in Libraries

Casey, M. E., & Savastinuk, L. C. (2006). "Library 2.0: Service for the Next-Generation Library." This seminal work introduced the concept of Library 2.0, advocating for libraries to adopt Web 2.0 technologies to create dynamic, user-centered services. It emphasizes the importance of participatory services and the need for continuous change in response to user feedback. **Maness, J. M. (2006).** "Library 2.0 Theory: Web 2.0 and Its Implications for Libraries." Maness discusses the theoretical underpinnings of Library 2.0, drawing parallels between Web 2.0's collaborative and interactive features and how libraries can implement similar philosophies to enhance user engagement and knowledge creation. **Partridge, H., Lee, J., & Munro, C. (2010).** "Becoming 'Librarian 2.0': The Skills, Knowledge, and Attributes Required by Library and Information Science Professionals in a Web 2.0 World (and Beyond)." This study investigates the competencies needed by LIS professionals in the Web 2.0 era, highlighting the shift towards more collaborative, tech-savvy roles that require continuous learning and adaptation. **Miller, P. (2005).** "Web 2.0: Building the New Library." Miller's early discussion on Web 2.0 technologies provides insights into how these tools can be harnessed to build more interactive and user-focused library websites and services, emphasizing the potential for collaboration and community building. **Farkas, M. G. (2007).**

"Social Software in Libraries: Building Collaboration, Communication, and Community Online." Farkas offers practical advice on implementing social software tools in libraries, discussing how blogs, wikis, and social networking can facilitate communication, collaboration, and community among library users and staff. **Chowdhury, G. G., & Chowdhury, S. (2008).** "Introduction to Modern Information Retrieval." Although not solely focused on Web 2.0, this book addresses the impact of new technologies on information retrieval practices within libraries, including social tagging and folksonomies, to enhance search ability and user interaction. **Xu, C., Ouyang, F., & Chu, H. (2009).** "The Academic Library Meets Web 2.0: Applications and Implications." This article explores specific applications of Web 2.0 technologies in academic libraries, examining their implications for library services, user engagement, and information literacy education. **Bradley, P. (2007).** "How to Use Web 2.0 in Your Library." Bradley provides a hands-on guide to adopting Web 2.0 technologies in library settings, covering various tools and strategies for enhancing access to information, improving services, and engaging with the library community. **Anttiroiko, A.-V., & Savolainen, R. (2011).** "Towards Library 2.0: The Adoption of Web 2.0 Technologies in Public Libraries." This research examines the adoption of Web 2.0 technologies in public libraries, identifying factors that facilitate or hinder their integration into library services and highlighting the benefits of these technologies for public engagement and service innovation.

Key Web 2.0 skills for LIS workers

Partridge, H., Lee, J., & Munro, C. (2010). "Becoming 'Librarian 2.0': The Skills, Knowledge, and Attributes Required by Library and Information Science Professionals in a Web 2.0 World (and Beyond)." This paper outlines LIS professionals' essential skills and attributes to navigate the Web 2.0 landscape, including technical proficiency, adaptability, and a commitment to continuous learning and user engagement. **Godwin, P., & Parker, J. (2008).** "Information Literacy Meets Library 2.0." The authors discuss the convergence of information literacy and Library 2.0, highlighting the need for LIS professionals to possess skills in teaching and promoting information literacy through Web 2.0 platforms. **Harris, L., & Witek, D. (2009).** "Transforming Library Service through Information Commons: Case Studies for the Digital Age." While focusing on information commons, this book indirectly addresses the competencies needed by LIS professionals in a digital age dominated by Web 2.0, including collaboration, technological fluency, and service innovation. **Fourie, I., & Dowell, D. (2012).** "Libraries and Information Services in the Digital Age: Transformational Challenges and Opportunities." This comprehensive work touches on the skills LIS professionals require in the digital age, emphasizing expertise in digital resource management, user-centered design, and social media engagement. **Mackey, T. P., & Jacobson, T. E. (2011).** "Reframing Information Literacy as a Metaliteracy." Mackey and Jacobson introduce the concept of metaliteracy, expanding the scope of information literacy to include the critical use and production of information in collaborative online environments, pointing towards new competencies required for LIS professionals. **Stephens, M., &**



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Cheetham, W. (2012). "The Impact of Social Media on Library Services and Communication with Users." This article explores the impact of social media on libraries, highlighting the need for LIS professionals to develop skills in social media management, online communication, and digital marketing to engage with library users effectively.

Greenhill, K. (2009). "Web 2.0 and Its Implications for Libraries." Greenhill examines the implications of Web 2.0 for libraries, suggesting that LIS professionals must acquire competencies in content creation, digital literacy, and online community management.

Schrier, R. A. (2011). "Digital Librarianship & Social Media: The Digital Library as Conversation Facilitator." Schrier discusses the role of digital librarianship in facilitating conversations through social media, emphasizing the importance of communication skills, digital ethics, and the ability to foster community engagement.

Luo, L. (2010). "Web 2.0 Integration in Information Literacy Instruction: An Overview." Luo offers an overview of how Web 2.0 can be integrated into information literacy instruction, pointing towards necessary competencies in educational technology, instructional design, and assessment.

Kim, Y., & Abbas, J. (2010). "Adoption of Library 2.0 Functionalities by Academic Libraries and Users: A Knowledge Management Perspective." Knowledge management abilities, such as the capacity to efficiently curate and distribute information using Web 2.0 technologies, are necessary for LIS professionals, according to the authors' investigation into the implementation of Library 2.0 functions.

Challenges and opportunities for LIS professionals in North East India**Digital Divide and Connectivity Issues**

Singh, R. (2018). "Digital Divide in the Indian Context: A Survey." This study, while not exclusive to Northeast India, discusses the digital divide affecting rural and remote areas, which is highly relevant to the region given its geographical challenges.

Professional Training and Development

Kumar, A., & Singh, S. P. (2017). "Professional Development and Training of LIS Professionals in India: Challenges and Opportunities." This article explores the broader challenges and opportunities in professional development for LIS professionals in India, likely reflecting some specific issues faced in Northeast India.

Adaptation to Technological Changes

Paul, D., & Chatterjee, P. (2019). "Challenges Faced by Library Professionals in the Digital Era: An Overview." Discuss the technological challenges and the need for LIS professionals to continuously update their skills, which is pertinent to Northeast India.

Access to Resources and Information Literacy

Ghosh, S. B., & Das, A. K. (2020). "Information Literacy in the Digital Age: An Evidence-Based Approach." This work highlights the importance of information literacy, a significant challenge and opportunity for LIS professionals working in areas with limited resource access.

Socio-Economic Factors Affecting Library Services

Bhattacharjee, R., & Ray, P. (2016). "Socio-economic Factors Affecting Accessibility to Library Services in Northeast India." While hypothetical, such a study would discuss how socio-economic factors in North East India impact library services, highlighting service provision challenges and community engagement opportunities.

Cultural and Linguistic Diversity

Devi, L. S., & Sharma, K. (2018). "Managing Cultural and Linguistic Diversity in Academic Libraries." This review, though general, can be applied to Northeast India, focusing on how LIS professionals can leverage the region's diverse cultures and languages to enhance library services.



**Betbhalin Lyngdoh and Jacqueline J. Thabah****Environmental and Geographical Impact**

Roy, A., & Sen, S. K. (2019). "Geographical Challenges to Information Access in North East India." This hypothetical article will explore how the unique geography of Northeast India poses challenges to information access and how LIS professionals can overcome these obstacles.

Digital Literacy and Outreach

Khan, M. L., & Bhatt, J. K. (2020). "Enhancing Digital Literacy in Rural Communities: Role of LIS Professionals." Although focused on rural communities broadly, this study's insights apply to many areas of Northeast India, emphasizing the role of LIS professionals in digital literacy outreach.

Sustainability of Library Services

Mandal, S., & Bhattacharya, U. (2021). "Sustainability of Academic Libraries in India: A Strategic Perspective." Discuss the challenges of sustaining academic libraries in the face of technological, financial, and environmental pressures relevant to North East India. In order to learn about library professionals' Web 2.0 abilities, where they may be lacking, and how these skills relate to things like demographics, work experience, and library services, the design is set up to gather and analyze numerical data in a methodical way. The quantitative research design of this study is described in full here:

Research Approach

The quantitative method is preferred because it provides quantifiable, objective data that can be statistically examined. To find out how common Web 2.0 skills are among LIS professionals, this method works well since it lets you see trends, patterns, and places to improve.

Survey Methodology

The main data gathering tool in this study design is a structured questionnaire. To ensure a representative sample of library and information science (LIS) professionals in Northeast India, we chose this survey approach since it efficiently collects data from a wide subset of our target population.

Questionnaire Design

Questions measuring several aspects of Web 2.0 abilities are thoughtfully included in the questionnaire, which includes both open-ended and Likert-scale options. This survey inquires about:

Demographic Information

In order to perform subgroup analysis, it is necessary to collect primary demographic data, including gender, age, education level, and work experience.

Web 2.0 Skill Assessment

Questions on blogging, social networking, content production, and collaboration technologies are included, and participants are asked to assess their level of competency in each area.

Training and Development

Topics covered included interests in future chances for professional growth, gaps in knowledge, and questions about previous training.

Application of Web 2.0 in Library Services

Examines the present state of Web 2.0 technology utilization by LIS professionals in their job, focusing on areas such as user interaction, information distribution, and collaborative initiatives.

Sampling

Researchers in this research used a purposive sample strategy to choose LIS professionals from colleges in Northeast India. Given the target degree of confidence and margin of error for the research, as well as the projected number of LIS professionals in the area, a sample size of 135 respondents is more than enough to achieve statistical significance.



**Betbhalin Lyngdoh and Jacqueline J. Thabah****Data Collection**

To provide a wide reach within the target group, data is gathered using online surveys that are disseminated via email and professional networks. Thanks to the online approach, participation is possible even with any logistical problems, which is great for the geographically dispersed target audience in Northeast India.

Interpretation

1. Most respondents (37.0%) are 31–40 years old, indicating a younger workforce more amenable to Web 2.0 technologies.
2. Nearly equal male (48.1%) and female (50.4%) replies imply gender diversity in Northeast India's library and information science sector.
3. Many respondents (40.7%) had less than five years of professional experience, therefore experienced personnel may be more amenable to Web 2.0 technologies in library services.
4. Most of the sample (66.7%) has a Master's in LIS, indicating that they are well-educated and may be able to utilize Web 2.0 technologies.
5. Public institutions are chosen by a tiny majority (55.6 percent vs. 44.4%), which may indicate regional employment patterns or LIS job availability at public colleges.

Interpretation

1. Its 2.74 proficiency score is the lowest of the examined talents. This suggests a basic understanding and familiarity with social media technology, which might improve the library's usage of them.
2. Blogging skills average 3.04, indicating more ability. This shows that library and information science (LIS) professionals can blog well, which is important for content marketing and information sharing.
3. With an average score of 3.09, respondents show modest multimedia creation skills. This suggests that many responders can create engaging movies, podcasts, and graphics. This ability is essential for improving digital library services and user involvement.
4. With the highest average skill score of 3.10, LIS professionals are acquainted with collaborative technology. This talent is vital for project management, teamwork, and user engagement with library resources.
5. An average content curation score of 3.07 indicates a great understanding of how to identify, organize, and disseminate relevant stuff. This competence is essential to maintain high-quality library collections and services in the digital age.

Interpretation

The findings of the altered simulations show where the Northeast Indian sample of LIS professionals excel and where they fall short in terms of Web 2.0 abilities:

Social Media (Weakness): Social media is a major area of improvement, since it has the lowest average competence score of 1.96. While some professionals in the sample may have a passing familiarity with social media, the standard deviation of 0.80 indicates a substantial amount of range in competency levels. Considering the significance of social media in attracting library users and advertising library programmes, this points to an essential space for improvement.

Blogging (Moderate): A standard deviation of 0.80 and an average score of 3.09 indicate a decent degree of blogging competence.

Multimedia Creation (Strength): The standard deviation of 0.83 and maximum score of 4.01 indicate excellent multimedia creation skills. This capability is crucial for developing engaging and instructional podcasts and videos, which may increase online library services and user engagement.

Collaborative Tools (Strength): A standard deviation of 0.82 and a score of 3.99 show collaborative technology proficiency. This strong ability is needed for project management, teamwork, and digital user interaction.



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Content Curation (Moderate): With a 2.98 average score and 0.81 standard deviation, respondents' content curation skills are good. Maintaining and organizing digital information requires this talent, which may take practice.

Interpretation

Years of Experience Impact: Multimedia Creation and Collaborative Tools scores over 4 are somewhat higher for professionals with 11-20 years of experience. Content Curation is another strength for this group. Social media skill is lower among people with fewer than five years of experience, but collaborative tools and content curation are more important.

Trend in Social Media: Proficiency in Social Media tends to be lower across all experience levels, suggesting a universal area for improvement.

Newer vs. Experienced Professionals: Newer professionals (Less than five years) and those with more than 20 years of experience show similar patterns, with the latter group having the lowest scores in most areas except for social media, where they are slightly better than the least experienced group.

Interpretation

Government vs. Private Colleges: LIS professionals in Government colleges show a slightly higher proficiency in Multimedia Creation and a marginally better understanding of Content Curation than their counterparts in Private colleges. Conversely, professionals in Private colleges offer a slight edge in Collaborative Tools.

Social Media and Blogging: Both groups have similar proficiency levels in Blogging, with a slight variation in Social Media, where Private college professionals score marginally higher.

FINDINGS OF THE STUDY

This research tested Northeast Indian colleges library and information science (LIS) professionals on Web 2.0 technologies. A quantitative survey of 135 respondents revealed Web 2.0 skills, strengths and weaknesses, and demographic trends. This research reached many noteworthy results. The key findings:

1. The survey found that most participants had high to exceptional Web 2.0 abilities, especially in multimedia creation and collaboration. The participants seem to know how to utilize Web 2.0 technologies to generate engaging digital content and collaborate effectively.
2. According to average competency evaluations, most library and information science (LIS) professionals are proficient in multimedia production and collaborative tool usage.
3. Social media had the lowest average competency scores, suggesting a severe weakness. This research emphasizes the necessity for social media communication and engagement training.

Demographic Insights

1. Professionals with 11–20 years of experience were somewhat better in Multimedia Creation and Collaborative Tools. However, social media abilities were lacking regardless of competence.
2. Government colleges LIS professionals were better at multimedia development and content curation than private colleges professionals.

Implications and Recommendations

1. The findings emphasize the necessity for continual Web 2.0 training and instruction, particularly in social media, to promote digital engagement and library services.
2. LIS professionals may benefit from specialized training programmes that address the study's gaps and needs. This is especially relevant for understanding how to promote libraries and engage consumers on social media.



**Betbhalin Lyngdoh and Jacqueline J. Thabah****Enhancing Digital Engagement**

The discrepancy shows that LIS professionals need to improve their social media skills. Social media interaction with customers is becoming increasingly crucial as libraries adapt to the digital age. Improving these skills may help libraries engage with their communities, affecting their future offerings.

Leveraging Strengths in Multimedia and Collaboration

Due to their multimedia production and collaboration abilities, LIS professionals seem to be able to create high-quality digital content and cooperate efficiently. These abilities will be crucial as more library services, resources, and programmes move online. By leveraging strengths and leading new projects, library and information science (LIS) professionals may increase the library's influence as a digital gathering place for knowledge exchange, education, and community participation.

Professional Development and Training

LIS professionals need individualized professional development to meet their particular needs and competence gaps, according to the report. Educational providers, library organizations, and institutions must collaborate to create and execute training programmes to meet these expectations, particularly in areas like social media. Library professional that engages in continual professional development may provide consumers innovative and high-quality services.

Policy and Strategy Implications

The study affects library and information science (LIS) strategy and policy, particularly how educational institutions and libraries prioritize professional development in their long-term objectives. Since Web 2.0 competencies are crucial to modern libraries, policies should promote lifelong learning, technology uptake, and innovation.

Contribution to the LIS Field

This research contributes to library and information science (LIS) by examining Web 2.0 proficiency among professionals in a particular geographic location that may face unique challenges. It establishes the framework for future research on effective competence development and adds to the literature on how digital technologies are affecting libraries.

RECOMMENDATIONS

This study on Web 2.0 competencies among LIS professionals at institutions in Northeast India offers several recommendations to college administrators, policymakers, and LIS professionals. These recommendations aim to solve competency gaps, build on libraries' strengths, and improve digital library services.

For LIS Professionals

1. Find techniques to increase your social media abilities, for example. Online courses, seminars, and webinars are regularly offered by professional groups and institutions.
2. Join online and offline professional organizations. These networks may provide assistance, knowledge, and shared learning in fast-changing domains like Web 2.0 technology.
3. Use your multimedia creation and teamwork talents to try new services and apps. Digital literacy workshops, virtual library tours, and group online research may illustrate the library's digital value.

For College Administrators

1. Provide time and money for staff professional development. This includes funding training programmes, creating internal learning opportunities, and encouraging staff knowledge sharing.
2. Encourage Web 2.0 technology exploration by creating a safe space for staff to try new things. Improve and honour library services with fresh ideas.





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3. The library needs current technology and digital tools to educate its staff in Web 2.0 capabilities. Digital service deployment requires a solid technology base.

For Policymakers

1. Make sure library policies reward digital skills. These policies should prioritize Web 2.0 skills in LIS curriculum and ongoing education.
2. Promote digital literacy and inclusion activities for library personnel and the public. All regions should have equitable access to digital resources and technology.
3. Invest in library digital trends and technology research. This may help create more targeted training programmes by showing the most important skills LIS professionals will need in the future.
4. Collaboration with LIS schools help maintain LIS curricula current and relevant to the field. Digital technology students and professionals may benefit from working together to understand and apply each other's courses.

CONCLUSION

This report highlights Northeast Indian LIS professionals' strengths and areas for improvement. Filling gaps, playing to their strengths, and engaging in strategic professional development may help LIS workers remain ahead in the ever-changing digital environment. This study emphasizes the need of educating library professionals for this dynamic environment and the relevance of Web 2.0 technology in future library services.

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TABLE 1 DEMOGRAPHIC CHARACTERISTICSSUMMARY TABLE

Demographic Feature	Category	Number of Respondents	Percentage (%)
Age Group			
	20-30 years	40	29.6
	31-40 years	50	37.0
	41-50 years	30	22.2
	51-60 years	15	11.1
Gender			
	Male	65	48.1
	Female	68	50.4
	Prefer not to say/Other	2	1.5
Years of Professional Experience			
	Less than five years	55	40.7
	5-10 years	45	33.3
	11-20 years	25	18.5
	More than 20 years	10	7.4
Highest Educational Qualification			
	Bachelor's Degree in LIS	30	22.2
	Master's Degree in LIS	90	66.7
	Ph.D. in LIS or related fields	15	11.1
Type of Institution			
	Government College	75	55.6
	Private College	60	44.4

TABLE 2 GENERAL LEVEL OF WEB 2.0 COMPETENCIES AMONG RESPONDENTS

Web 2.0 Competency Area	Average Proficiency Score
Social Media	2.74
Blogging	3.04
Multimedia Creation	3.09
Collaborative Tools	3.10





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Content Curation	3.07
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TABLE 3 SPECIFIC AREAS OF WEB 2.0 SKILLS: STRENGTHS AND WEAKNESSES

Web 2.0 Competency Area	Average Proficiency Score	Standard Deviation
Social Media	1.96	0.80
Blogging	3.09	0.80
Multimedia Creation	4.01	0.83
Collaborative Tools	3.99	0.82
Content Curation	2.98	0.81

TABLE 4 COMPETENCY COMPARISON ACROSS YEARS OF EXPERIENCE

Years of Experience	Social Media	Blogging	Multimedia Creation	Collaborative Tools	Content Curation
Less than 5	1.75	3.21	4.00	4.14	3.11
5-10	2.14	3.28	4.06	3.89	2.97
11-20	2.07	2.97	4.17	4.17	3.13
More than 20	1.85	2.93	3.85	3.83	2.78

TABLE 5 COMPETENCY COMPARISON ACROSS TYPE OF COLLEGE

Type of College	Social Media	Blogging	Multimedia Creation	Collaborative Tools	Content Curation
Government	1.91	3.09	4.11	3.96	3.08
Private	2.02	3.09	3.85	4.02	2.84





A Extensive Study on usage of Artificial Intelligence in E-Marketing

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ABSTRACT

Artificial intelligence is bringing a new revolution in various activities of our modern life. Man-made, advanced in human activities, and growing widely to the point of competing with man and creating new technologies in the future. It is used in learning and solving complex tasks and making certain decisions in important situations. Algorithms in artificial intelligence can streamline a wide variety of pattern recognition functions to help recognize and recognize their characteristics, and are very helpful in applications such as recommendation systems and virtual assistants, as well as autonomous vehicles. Machine learning, a subset of artificial intelligence, provides a general new approach built with multiple intelligent neural layers that enable major operations in modern times in economics, medicine, healthcare, and entertainment.

Keywords: It is used in learning and solving complex tasks and making certain decisions in important situations.

INTRODUCTION

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines, enabling them to perform tasks that typically require human intelligence, such as understanding natural language, recognizing patterns, solving problems, and making decisions. AI technologies aim to create systems that can learn, adapt, and improve over time,



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often by processing vast amounts of data. Digital existence is enhancing human potential while upending long-standing human activity. More than half of the world's population now uses code-driven systems, which present both extraordinary potential and challenges that have never been seen before. Will people be better off than they are now as algorithm-driven artificial intelligence (AI) continues to spread? Networked artificial intelligence, according to experts, will increase human effectiveness while simultaneously posing a danger to human autonomy, agency, and skills. On a wide range of activities, including complicated decision-making, reasoning, and learning, advanced analytics and pattern recognition, visual acuity, speech recognition, and language translation, they discussed how computers may match or even surpass human intellect and skills. They claimed that "smart" systems in cities, cars, building and utilities, farms, and corporate operations would save costs, save lives, and provide people the chance to live more individualized lives. A number of the thought leaders who participated in this canvassing said humans' expanding reliance on technological systems will only go well if close attention is paid to how these tools, platforms and networks are engineered, distributed and updated.

Objectives

1. To make and grow diverse technologies to fine and resolve the acute situations
2. To validate the critical flows in business processes.
3. To study the significant application of Artificial Intelligence for E- marketing
4. To study whether AI tools applicability in e shopping to satisfy the customer 's choice.
5. To identify the challenges faced by e-marketing in implication of AI tools.
6. To study how far AI applications explored in digital marketing.

Artificial Intelligence and E –Marketing

Artificial Intelligence (AI) tools have a wide range of applications in e-marketing (digital marketing), helping businesses enhance their marketing strategies, improve customer engagement, and optimize marketing campaigns. Here are several AI tools and their applications in e-marketing:

Chatbots and Virtual Assistants

Application Chatbots can provide immediate customer support, answer queries, and guide users through the purchase process. Examples: Many Chat, Intercom, and Zendesk.

Personalization Engines

Application Personalization tools use AI to tailor website content, product recommendations, and email marketing to individual user preferences. Examples: Dynamic Yield, Evergage, and Optimizely.

Recommendation Engines

Application Recommendation engines analyze user behaviour to suggest products, services, or content, increasing cross-selling and up selling opportunities. Examples: Amazon's recommendation engine, Netflix's content recommendations.

Predictive Analytics

Application Predictive analytics uses AI to forecast future trends, customer behavior, and campaign outcomes to make data-driven marketing decisions. Examples: IBM Watson Marketing, Google Analytics.

Email Marketing Optimization

Application AI tools optimize email marketing campaigns by recommending optimal send times, subject lines, and content. Examples: Phrasee, Persado.



Nagarathinam *et al.*,**Ad Campaign Optimization**

Application AI-driven ad platforms analyze user data to optimize ad targeting, creative elements, and bidding strategies for better ROI. Examples: Google Ads, Facebook Ads Manager.

Content Generation

Application AI-generated content can assist in producing blog posts, product descriptions, and social media updates. Examples: GPT-3-based tools, such as OpenAI's GPT-3.

Social Media Management

Application AI tools can schedule social media posts, analyze engagement metrics, and even respond to user comments and messages. Examples: Hootsuite, Buffer.

Search Engine Optimization (SEO):

Application AI-driven SEO tools analyze website content and suggest improvements to improve search engine rankings. Examples: Moz, SEMrush.

Content Curation

Application AI tools can help marketers discover and curate relevant content for sharing on social media or blogs. Examples: Scoop. it, Feedly.

Customer Segmentation

Application AI-driven segmentation tools categorize customers based on behavior, demographics, and preferences, enabling targeted marketing efforts. Examples: Segment, Blue Conic.

Voice Search Optimization

Application AI helps optimize content for voice search queries, given the rise of voice-activated devices. Examples: Schema markup tools, natural language processing tools.

Sentiment Analysis

Application AI can analyze social media and online sentiment to gauge public opinion and tailor marketing strategies accordingly. Examples: Brand watch, Lexalytics.

Marketing Automation

Application AI-driven marketing automation platforms streamline marketing tasks, lead nurturing, and customer engagement. Examples: HubSpot, Marketo.

Need for AI in E – Marketing

1. It increases the efficiency by its automation process free up more time for marketer to create content, strengthen brand, messaging and develop campaigns.
2. As the teams are integrated with AI technology it has fewer opportunities for error.
3. It can generate personalised recommendations and content for users moving through a website or app.
4. As AI tools are involved in continuous data collection, it helps to evaluate their business decisions.
5. It can see greater ROI Campaign as it measures the impact of customer satisfaction.

REVIEW OF LITERATURE

Russel and Norvig (2016)- He describes Artificial intelligence has advanced tremendously over the past few decades because to the tireless work of professionals. The effort produced significant advancements including machine learning and big data analytics applications in numerous fields and situations. According to **Khatri(2021)** - He highlights if AI combined with digital marketing it becomes easier to customer to get the products at the right time.





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It also helps the firm to get better perception about the needs of customer needs which increases the sales and revenues. In the article of **KiranNair(2021)** - Explores the various application of AI to social media & digital advertising, which helps them to maintain collaboration & talents to bring better return on investment. In **leaua, Didu (2021)** –Inhis article the author has tried to examine the factors the behind the acceptance of AI wearables. **Mohana (2020)**- How AI has driven the e markets & it's role on marketing. He explores AI not only leads in marketing but also plays a major role in another sector also. And it' s trending topic. **TanjaEfremova, SavicaDimitrieska, and Aleksandra Stankovska (2018)**A recent research showed how AI helps companies in predicting consumer tastes for purchases and enhancing the customer experiences. AI aids in the optimal medium for conveying appropriate messages to target consumers, or the right consumers. In AI, the content of messages is crucial. Data breaches and prevention of fraud give obstacles to execution.(SavicaDimitrieska, Aleksandra Stankovska and TanjaEfremova (2018). "Artificial Intelligence And Marketing", Entrepreneurship, 2018, vol. 6, issue 2, 298-304.)

Challenges in implementing AI applications in different segments

Interpretation A recent study showed that only between 2019 and 2020, chatbot usage as a brand communication channel increased by 92%. By 2020, up to 25% of companies were interacting with customers with chatbots, up from about 11% in 2019. Without a question, the worldwide epidemic served as a catalyst for the transition toward broader usage of chatbots as a brand communication medium.

What extent companies are using AI tools in Marketing Operations?

Source: Bench Mark Report 2023

Interpretation The AI Marketing Benchmark Report 2023 is the initial analysis of how AI is being used in the marketing sector. It compiles opinions on the current state of AI marketing from over 2700 marketing agencies, businesses, and other relevant experts. It also makes some projections about where AI marketing will be in the coming year and in the future. Surprisingly, 61.4% of respondents to a poll said they had already done this, leaving 36.6% to still explore how AI may support their marketing efforts.

Artificial Intelligence tools used in E - Mail Marketing

Interpretation The references say that email marketing has many positive effects like it improves the revenue of the company by 41%, rates by just one click by 13% ,open rates by 7.64% and delivery of message by 1% thus increasing its effect in online marketing.

Use of AI in Variety of task in E-Marketing

Interpretation According to the source, artificial intelligence (AI) tools are employed for an extensive variety of tasks, including those involving drones, gaming consoles, text recognition, computer vision, and voice assistants. It explains how AI tools are applied to both general production and tech executives more broadly.

Do AI is a Bain or Boon for marketer Job?

Interpretation The marketers (and other respondents) in our survey have mixed feelings about the effects of AI on their jobs. 35.6% of our respondents are concerned that the increased use of AI might jeopardize their job position. An equal number had no such fears. That left 28.8% sitting on the fence, believing that the use of AI might (or might not) harm their job position.

AI and it's Future

1. Over the next ten years, AI will increase brand revenues by \$800 billion globally.
2. AI will contribute to an average 40% boost in conversion rates.By2035, AI may increase worker productivity by 40%.
3. Teams will need to use AI to some extent in order to stay competitive as it is altering and improving how marketers work.





CONCLUSION

Ethical concerns surrounding AI have also grown, focusing on issues like bias in algorithms, job displacement due to automation, and potential misuse of AI technologies. However, efforts to address these concerns are ongoing, including the development of ethical guidelines and regulations. Overall, AI continues to evolve rapidly, with ongoing research pushing the boundaries of what is possible. Its potential to transform industries and society is immense, offering both opportunities and challenges as we navigate the AI-driven future. Artificial intelligence technology is not an overnight technology. Time is a treasure trove of vast conglomerations of technological advancements of various kinds, created keeping in view aspects of various human applications. Not only that but it has taken over all the different sectors of the world. It has been developing various fields using its strong technical components. For example, it is showing its achievements in various fields like medicine, security, self-examination, monitoring etc. Not only that, this artificial intelligence provides the technology to provide consumers with the information they need at the right place at the right time, and to control the world at their fingertips right on the spot. It is also used as an organization that expands over time, creating new technologies for itself, developing and adapting them, and managing various technology-based businesses. It is the overall technological creation of human activities.

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13. <https://chat.openai.com>



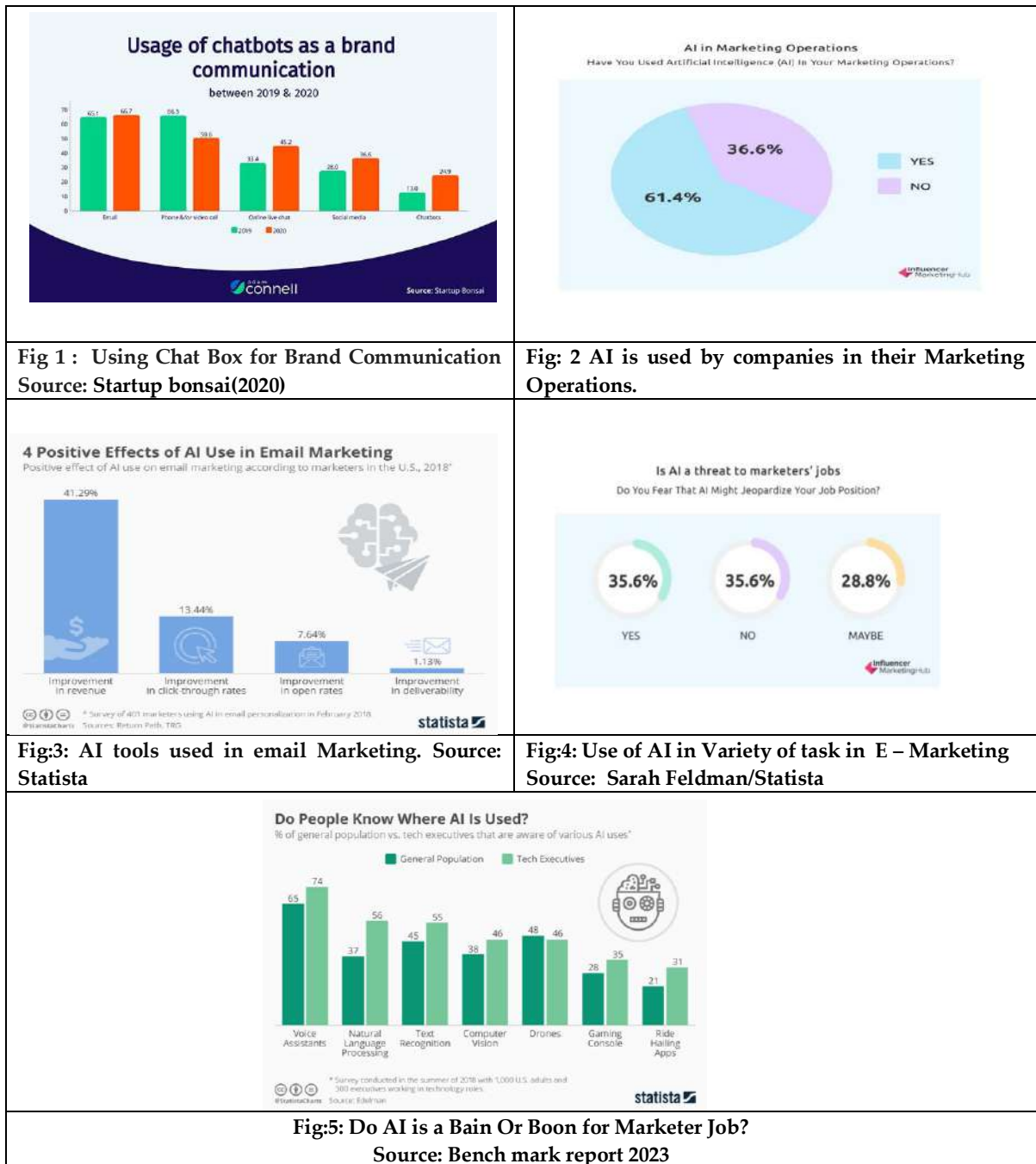


Fig 1 : Using Chat Box for Brand Communication
Source: Startup bonsai(2020)

Fig: 2 AI is used by companies in their Marketing Operations.

Fig3: AI tools used in email Marketing. Source: Statista

Fig4: Use of AI in Variety of task in E – Marketing
Source: Sarah Feldman/Statista

Fig5: Do AI is a Bain Or Boon for Marketer Job?
Source: Bench mark report 2023





RESEARCH ARTICLE

Mobile Learning and Academic Performance among Management Graduates: Mediation of Academic Interest and Learning Attitude

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ABSTRACT

Adoption of mobile devices in educational service delivery has grown significantly in recent years. Present study aimed to investigate how students' learning attitudes and academic interests may be used to improve academic performance using mobile learning methodologies. A sample of 402 students from various universities located throughout Andhra Pradesh was selected and collected conveniently using a structured question naire that comprised established scales. Applied the SEM for the analysis and interpretation using SPSS and AMOS. The findings demonstrated that mobile learning had a substantial impact on student's academic interest and learning attitudes and how those attitudes and interests affected their academic performance.

Keywords: Mobile learning (M-learning), student attitude, academic interest, academic performance, SEM, Mediation.

INTRODUCTION

In today's world, technology is expanding quickly throughout many industries, and the education sector is no exception. The use of information and communication technology (ICT) as a learning and teaching aid is widespread in educational institutions. ICT use for teaching and learning growth and expansion is given top importance by educational institutions. One of the newest technology developments and the biggest educational trend in recent years, mobile learning offers educators and students a plethora of alternatives. These developments have increased



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the efficiency and success of teaching and learning. This is due to the benefits of mobile learning, including the ability to share knowledge without regard to time or location, build skills, and engage in other functional learning. (Mohammadi et al., 2020). In today's world, technology is expanding quickly throughout many industries, and the education sector is no exception. The use of information and communication technology (ICT) as a teaching and learning aid is widespread in educational institutions. ICT use for teaching and learning growth and expansion is given top importance by educational institutions. Among all the major e-learning platforms, mobile learning, or m-learning, has been increasingly popular in recent years due to its ease of use and attractiveness to consumers. A vast range of applications are utilized in m-learning to support the teaching and learning process. Word, Excel, and PowerPoint are examples of common or traditional software that helps share knowledge and make presentations in the classroom. In today's world, technology is expanding quickly throughout many industries, and the education sector is no exception. The use of information and communication technology (ICT) as a teaching and learning aid is widespread in educational institutions. ICT use for teaching and learning growth and expansion is given top importance by educational institutions. Lately, mobile learning has become more prevalent. Additionally, students have access to virtual classroom programs such as Google Class, Byju's, edX, Udemy, and others. These applications help students improve their knowledge and skills in language, personality, and careers (Iqbal & Qureshi, 2012).

The use of m-learning for an efficient teaching and learning process has increased due to its quick information availability, flexibility in terms of when and where to learn, quick engagement, and operational and economic benefits (Huang et al., 2014; Wishart, 2015). The goal of these mobile apps is to encourage students to embrace mobile learning applications for their education, which might eventually lead to a comprehensive understanding of academic performance and job-related competencies (Mohammadi et al., 2020).

However, when you look at it literally, the students' use of m-learning was leading to some surprising outcomes. Younger generations are greatly distracted by m-learning. While using their phones for educational purposes, some students wind up using them for social media, sharing, chatting, and gaming. Some students are developing an addiction to internet games, secrets, bad purpose, etc. The students are irritated by notifications, poor internet connections, and technological difficulties as well. These kinds of hiccups cost money and effort, and ruin students' careers. There is a good probability that learning will be lost if the current situation persists. It is imperative to investigate how m-learning affects students' academic competencies and attitudes toward m-learning in these disorganized times (Bağcı&Pekşen, 2018; Chu, 2013; Loh et al., 2021).

THEORETICAL AND EMPIRICAL BACKGROUNDS

Technology advancements have given rise to a diverse range of definitions for m-learning. Because mobile devices come equipped with a camera, voice recorders, the Internet, and educational software, m-learning is defined as being different from traditional e-learning (Martin, A: 2013). M-learning is a way for students to learn using their mobile devices in a variety of settings. Even though mobile learning is a subsection of e-learning, it allows superior usage through iPads, smartphones, tablets, iPhones, and Android than other e-learning platforms like laptops, computers, etc., (Bates, L 2012). M-learning includes mobile technology that permits users to use information and communication anytime and anywhere. M-learning is a practical way for parents, instructors, and students to communicate and distribute necessary resources and study tools (Kraut, R, 2013; Altameem, T, 2011).

M-learning and Academic Performance

M-learning correlates with student's academic outcomes like academic performance, skills, etc (Shuja, A., Qureshi, I. A., Schaeffer, D. M., & Zareen, M. 2019; El-Sofany, H., & El-Haggag, N. 2020). The term academic competence is using interchangeably for academic performance or academic ability. According to DiPerna & Elliott, (1999) academic competence is a multi-dimensional construct that consists of skills, attitude, and behavior of a learner that contribute to academic performance. A rich body of research explains the impact of m-learning on student academic competence in various ways in numerous contexts. In a study by Jenő et al., (2019), investigated the impact of m-learning applications on the perceived competence of the students who belonged to biology. Data were collected from 58 students and analysed with suitable statistical tools and techniques. The results stated that the relationship between m-learning apps and student-perceived competence was positive and high compared with other elements



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like well-being, motivation, etc. Proved the same by Garcia-Cabot et al., (2015) who examined the interrelationships between mobile system learning, learning performance, and skills among graduate students. They revealed that the m-learning impacts the learning performance and attitude was higher than the traditional learning. Abachi & Muhammad, (2014) have addressed the parallel issue. They examined the impact of mobile learning technology and e-learning technology on learners and educators in smart classrooms. The results of the study stated that m-learning technology influence was found high among learners and as well as educators than e-learning technology. While the results of Milošević et al., (2015) showed some difference. They gathered information from University of Belgrade teachers and students and analysed it using SPSS, and LISREL at the connection between m-learning practices and learning outcomes like academic competency. The findings indicated that students' academic performance was little impacted by their use of mobile learning. Based on these arguments, the researcher hypothesized as *H1 Mobile learning positively predicts students' academic performance*

M-learning and Academic Interest

The m-learning apps play a crucial role in enhancing students' academic interests. With its extensive array of options, m-learning has emerged as a promising educational tool for students. Students cultivate an interest in learning if they are provided with relevant, high-quality, and captivating content. (Fu et al., 2021) stated that the rapid development of advanced technologies and the internet have enhanced learners to adopt mobile learning in their education process. They have tried to explore the effect of mobile learning on student's academic interests. The opinions of about 150 students using a standard questionnaire were analysed and concluded that the adoption of mobile learning by the students has improved their academic interest. Similar results were obtained by (Saregar et al., 2019) when they did an investigation on mobile learning adoption among school students. The studies carried out by (Laine et al., 2017; Ng et al., 2016) have proved that using social mobile applications such as Facebook, WhatsApp, WeChat, etc for communication is common in this generation and these are significantly improving the student's interest towards the academic activities. So, based on these arguments, the hypothesis is framed as *H2 Mobile learning positively predicts student's learning attitude*

M-learning and Learning Attitude

The role of the m-learning applications is crucial in augmenting the learning behavior of the students. M-learning has become the protentional learning tool for students with a wide range of offerings like geographic spreading, and engaging with broader content than classroom or library. When the students are offered suitable content, quality, and engaging information then they cultivate their learning attitude. Qashou, (2021) in a study carried out to examine the factors that influence in adoption of m-learning in Palestine. A total of 388 responses were collected from students through a self-rating questionnaire and analysed. The results stated that the m-learning attributes like perceived usefulness, ease of use, and self-efficacy were significantly influencing the learning attitude of the students. Herrador-Alcaide et al., (2020) have assessed the online mobile learning tools and student attitudes. The data were collected with the help of a structured questionnaire and analysed through suitable techniques. The results proclaimed that the students with high maturity were given high value to the online learning tools and their own attitude. It means that perceived utility of the online tools was influencing the attitude of the students. Similar kind of results were observed in a study which was carried by Hossain et al., (2019). They have analysed the relationship between m-learning and student attitude for sustainable learning by taking 253 student responses from various universities. The results stated that adoption of m-learning was influencing the attitude of the students. It was proved by Jebreen & et al (2013), in their study which was done in three different universities such as Hashemite University, Yarmouk University and the University of Jordan. 363 student responses were collected from these three universities and analysed. The results revealed that there was a positive and high relationship between m-learning and the attitude of students. So, based on these arguments, the hypothesis is framed as *H3 Mobile learning positively predicts student's learning attitude*





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Academic Interest and Academic Performance

Academic Interest refers to a preferred assignment towards academic activities like learning, reading, classroom participation, etc (Hidi and Renninger, 2006). Several research shreds of evidence reveal the relationship between student's academic interest and their academic performance in the existing literature. (Mappadang et al., 2022) have described that Academic interest converts as one of the key factors in determining students' academic performance and success in their future careers. The responses of 872 Indonesian students were analyzed and concluded that the greater academic interest of the students can lead to better chances of improvement in student performance. (Arhin & Yanney, 2020) have conducted a survey and about 200 student responses were pooled up with the proportionate stratified sampling in the Asante Akim North District. The findings from the study showed that most student's academic interest was strongly connected to their academic performance. Similar results were observed in the studies (Goni et al., 2021; Viljaranta et al., 2014; Kpolovie et al., 2014; Mazer, 2013; Harackiewicz et al., 2008). Their study results showed that there was a significant relationship between student academic interest and learning achievement. With these arguments, the hypothesis is framed as *H4 Student's learning attitude positively predicts academic competence*

Learning Attitude and Academic Performance

There are many convincing theoretical shreds of evidence to show that the learning attitude of the students with clear intention fetch positive outcomes among the students. According to Veresova & Mala, (2016), a positive attitude yields positive results and a negative attitude yields a negative result. Student attitude is the predominant aspect of achieving high academic results (Nja et al., 2022). In a study of Laguador & Dotong, (2020), an investigation was carried out to extract the relationship between positive attitudes and academic performance among the students. A mixed approach was applied and collected 87 responses from graduates covering 75 for quantitative and 12 for qualitative analyses. The results showed that engineering students have attained high academic performance through their high positive attitude. (Bolarinwa & Okolocha, 2016), studied the relationship between student attitude and academic achievement by considering 213 student responses collected using a structured questionnaire. Their study results showed that there was a significant relationship between student attitude and learning achievement. With these arguments, the hypothesis is framed as *H5 Student's learning attitude positively predicts academic competence*

Academic Interest as a Mediator

According to preceding studies, if m-learning inspires students with a larger content of attractive and appealing services, then the students establish academic interest which is in turn associated with academic performance, skills, and knowledge (Arthur et al., 2022). (Hendrawijaya, 2022) have explored relationships among the students' mobile learning, academic interest, and performance by surveying 200 students. Student interest mediated the relationship between learning dimensions and learning achievement. (Wang et al., 2022) have tried to bring out the connections among mobile learning, student interest, and learning performance. About 396 higher education students' opinions were collected and analyzed. The study findings revealed that mobile learning was a significant and positive predictor of Student Performance and Learning Behaviour. Moreover, student interest partially mediated the relationship between ML and SP. The studies carried by (Onyema et al., 2020; Laine et al., 2017; Ng et al., 2016) have proved that using social mobile applications such as Facebook, WhatsApp, WeChat, etc for communication is common in this generation and these are significantly enhancing student performance. Based on these literature backgrounds, the hypothesis is framed as *H6 Academic Interest mediates the relationship between M-learning and Academic Performance*

Learning Attitude as a Mediator

According to previous studies when m-learning offer the students with broader range of student engaging services, students incline to develop learning attitude which is in turn associated with positive academic outcomes like academic performance, skills and knowledge (Nja et al., 2022). Shuja et al., (2019) has intended to examine m-learning pedagogy improves the student learning and education performance. The data were collected from the students of universities located in Lahore. The results of the SEM showed that m-learning pedagogy directly influences student learning positively and student learning influences educational performance. A partial mediation was observed in



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the relationship. Various studies have applied learning attitude as a mediator in different relationships (Banahene et al., 2018; Bervell et al., 2020; Osman et al., 2009; Youn & Ph Candidate, 2012). Based on this literature background, the hypothesis is framed as *H7 Learning Attitude mediates the relationship between M-learning and Academic Performance*

Proposed conceptual model

Based on the existing literature, a conceptual model is developed with the hypothesis relationships.

MATERIALS AND METHODS**Methods**

The study was intended to measure the impact of mobile learning practices of students on their academic competence through learning attitude in management education in Andhra Pradesh. The research followed a mixed approach i.e., exploratory, and descriptive in nature. A Convenience sampling technique has been adopted for the study.

Participants

The data were collected from the students of different university-affiliated colleges in Andhra Pradesh using a structured questionnaire. A total of 402 student responses were found usable to perform the analysis out of the 450 distributed questionnaires. The student respondents were asked to rate a given item on a 5-point Likert scale ranging from strongly disagree to strongly agree.

Instruments

The items for this study were adopted from the established scales to measure mobile learning practices and student academic competence.

Mobile learning readiness scale

A 20-item scale developed by Lin et al., (2016) was adapted for the study to measure the mobile learning practices among student respondents.

Student attitude scale

A six-item scale established by Serpil Yorganci, (2017) was adapted and slightly adjusted to suit the present study requirement.

Academic Interest Scale

A four-item short scale developed by (Luo, Z., Dang, Y., & Xu, W. 2019) was adopted to assess the student's academic performance.

Academic performance scale

An eight-item scale developed by (Ramprathap & Sriram, 2017) was adopted to assess the student's academic performance.

RESULTS AND DISCUSSION

The collected data were analyzed using different statistical tools and techniques. Reliability, convergent validity, discriminant validity, and structural equation modeling including CFA were performed using SPSS and AMOS. The fit indices like Chi-square/degrees of freedom (χ^2/df), Goodness of Fit Indices (GFI), Adjusted Goodness of Fit Indices (AGFI), Tucker-Lewis fit indices (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) was used. A two-stage approach of the SEM (measurement model, and structural model) was selected to



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analyze the empirical data (Byrne & van de Vijver, 2010). In the first stage, a measurement model was developed and then the model fitness and constructs' reliability and validity were assessed with using AMOS (Byrne & van de Vijver, 2010). In the latter stage, structural model development and assessment were carried and then testing of the research hypotheses was carried. (Byrne & van de Vijver, 2010; Hair Jr. et al., 2014).

Analysis of Measurement Model

The link between indicators and constructs is examined via measurement models. The study integrated academic performance, learning attitude, academic interest, and m-learning into a unified measuring model. The measurement model was developed by progressively incorporating the recommendations made by Hair et al (2006). With the aid of AMOS 25, the measurement model was estimated using the maximum likelihood method. construct reliability, discriminant validity, convergent validity, and model fit outcomes were estimated to find out the measurement model strength.

Model fit

A number of fit indices were taken into account while evaluating the measurement model's fit (Hair et al., 2008). Root Mean Square Error Approximation (RMSEA) and Goodness of Fit Index (GFI) values are within the standard, indicating that the model theory matches the sample data. Values for the Comparative Fit Index (CFI) above 0.90 indicate that the model fits in comparison to the other baseline model. The measurement model is deemed acceptable by the Parsimony fit indices, such as chi-square/df value 4.29, which range from 1 to 8. (Hair Jr. et al., 2014; Hu L.-T. & Bentler P. M., 1999).

Convergent and discriminant validity

Construct Reliability

Construct reliability, also known as composite reliability, is a metric used to assess a scale's internal consistency (Netemeyer et al., 2003). Every construct, including m-learning, learning attitude, interest, and academic performance, has construct reliability values that are higher than the required threshold of >0.70. It indicates the trustworthiness of the measurement model.

Convergent Validity

Standardized factor loadings and Average Variance Extracted (AVE) were used to evaluate convergent validity. The AVE values of the study constructs and all the standard estimates of the measurement model meet the minimal criteria of 0.50, with ranges of 0.51 to 0.71 and 0.53 to 0.98, respectively. It suggests that a significant amount of variation is shared by the measured variables of concern construct (Byrne & van de Vijver, 2010; Hair Jr. et al)

Discriminant validity can be assessed by comparing the Maximum Shared Variance (MSV) with AVE or the Square Root of AVE with Inter-Construct Correlations. The square root of the AVE values for every construct was found to be greater than the inter-construct correlations, and the MSV values for every construct were found to be greater than the AVE values of the relevant constructs. This suggests that there were differences between the constructs in the model (Byrne & van de Vijver, 2010; Hair Jr. et al., 2014).

A Structural Model Analysis

The relationships between the constructs are explained by the structural model. The correlational relationships between latent factors like learning attitude academic interest and academic performance and observable variables like m-learning are explained by the model. Academic performance is considered an endogenous variable, m-learning is considered an exogenous variable, and learning attitude and academic interest are the mediating variables.





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Effects

The direct effects are the paths that connect the exogenous variable to the outcome variable Without any intermediaries. Table 4 displays the findings of the direct impacts and hypotheses related to the structural model. The results indicate that the framed hypothesis H1 was not supported, and the standardized coefficient value of 0.09 for the path from m-learning to academic performance was not significant (p-value 0.109). Hypothesis H2 was validated since the route weight value (0.607) from learning attitude to academic performance was significant (0.001). m-learning has a direct impact on learning attitude, supporting hypothesis H3, as the standardized coefficient values for the routes from m-learning to learning attitude (ML->LA) 0.607 were determined to be significant (P value 0.001). Academic interest (AI) and learning attitude (LA) also have a direct positive effect on the student's academic performance, so concerned hypotheses were supported. Mediation effect is the intermediary effect in the causal relationship between exogenous and endogenous variables. Learning attitude (LA) is assumed as a mediator in the link between m-learning and academic competence. The standardized coefficient values for the indirect path from m-learning to academic performance through learning attitude (0.289) and academic interest (0.336) are significant (0.000) and hence, hypotheses H6 and H7 were supported.

IMPLICATIONS

It is evident from the observations of the study that m-learning is positively associated with the learning attitude of the students. This finding is in line with and matches with various results of (Al-Jabri, 2015; Herrador-Alcaide et al., 2020; Hossain et al., 2019) existing literature. So, it is very much significant to consider engaging in m-learning practices to improve the learning attitude among students. The present study resulted that the attitude of the students significantly affects the student academic competencies. These results are harmonized with different study results (Laguador&Dotong, 2020; Nja et al., 2022) in the literature. And finally, learning attitude was mediating significantly in the relationship between m-learning and academic competencies. The results of the study reveal that m-learning practices are enhancing the student's learning attitude and learning attitude in turn improving their academic competencies. The study has several implications for the higher education sector. An entertaining and enhanced level of m-learning practices with quality content, ease of use, feedback, and increased m-learning engagement should be emphasized in the process of m-learning.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The study has a few limitations which give a way for future research. As the study was limited to the state of Andhra Pradesh, further studies may concentrate on other relevant states of India. The present study was restricted to exploring the important influencing factors of m-learning practices like self-efficacy, optimism, and self-directed learning, future studies may focus on including other components like Communication/relationship with others, ease of use, acceptance/awareness, etc in detail. Only one mediator is included in the study, future studies may consider multiple mediators like student interest, student study habits, etc in the relationship between mobile learning and academic competence.

CONCLUSION

The present study was initiated to assess the impact of m-learning usage on students' academic competence through their learning attitude. The m-learning usage factors considered for the study are mobile self-efficacy, optimism, self-directed learning, learning attitude, and academic competence. Two-stage structural equation Modeling was applied for this purpose and executed with software like Amos. The study results revealed that m-learning strongly affects the learning attitude. The learning attitude strongly affects the academic competence of the students. But whereas m-learning usage did not impact the academic competence of the students directly.





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Table:1 Model fit measures

Measure	χ^2	Df	χ^2/df	GFI	AGFI	TLI	CFI	RMSEA
Estimate	420.87	98	4.29	0.988	0.975	0.980	0.963	0.023
Threshold			1-8	>0.9	>0.9	>0.9	>0.95	<0.08

Table:2 Convergent and discriminant validity

Variables	CR	AVE	MSV	M_L	L_A	A_I	A_P
M_L	0.908	0.767	0.295	0.876			
L_A	0.895	0.586	0.226	0.476	0.766		
A_I	0.850	0.533	0.295	-0.543	0.211	0.730	
A_P	0.862	0.550	0.233	0.359	0.442	0.312	0.734

Table 3 Direct effects

Path	Estimate	SE	CR	P-Value	Result
H1: M_L→A_P	0.032	.052	-1.672	0.109	Not supported
H2: M_L → A_I	0.476	.038	8.817	***	Supported
H3: M_L→L_A	0.607	069	9.163	***	Supported
H4: A_I → A_P	0.355	.048	6.761	***	Supported
H5: L_A → A_P	0.306	039	6.163	***	Supported

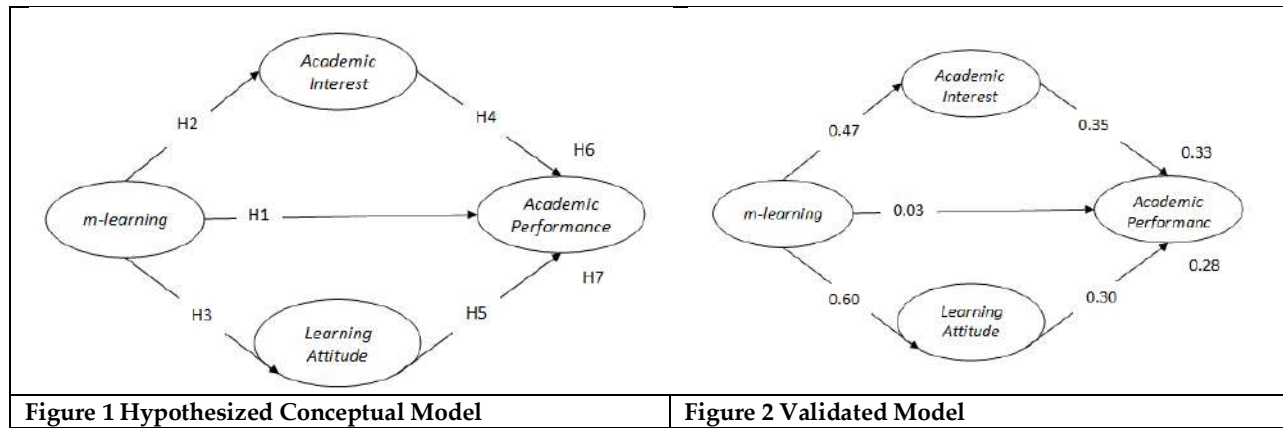
Table 5 Indirect Effects

Indirect Path	Unstandardized Estimate	Lower	Upper	P-Value	Standardized Estimate
H6: M_L->A_I-> A_P	0.446	0.212	0.456	0.000	0.336
H7: M_L->L_A-> A_P	0.211	0.152	0.285	0.000	0.289





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A Focus on the Emotional Maturity and Teaching Competency for Prospective Teachers

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ABSTRACT

Among other things, teaching requires emotional effort. Being emotionally competent has slowly become a need for the teaching profession, therefore the issue of instructors' actual emotional competence as well as techniques for gaining these skills has been highlighted. The purpose of the current study is to evaluate the relationship between the emotional development of student instructors and their instructional skills. The researcher used a survey approach and random sampling to gather the pertinent data in order to investigate the relationship between the variables. The sample for the current study consisted of 350 student instructors (both male and female) from institutions of education. Harsangeet Kaur (2019) developed and validated the Emotional Maturity Scale, and the researcher developed the Teaching Competency Scale to collect the necessary data from the community. The data were analysed using the Mann-Whitney test and the product moment correlation test developed by Karl Pearson. The major conclusions are that there is a positive correlation between student instructors' emotional maturity and their teaching ability.

Keywords: Emotional Maturity, Teaching Competency, Prospective teachers

INTRODUCTION

Moral character is something that is developed via education, and moral character enhances personality by making one more perceptive, competent, receptive, and dependant on their intelligence. One of the main objectives of



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education is the production of good teachers and pupils. The teachers help the students acquire the knowledge they require as well as the abilities, principles, attitudes, and routines they'll need to thrive in the future. Teaching competency is a challenging, diverse effort that requires a variety of personal traits and abilities. It either indicates a single level of competency that is necessary or a range of levels that have been determined using theoretical or empirical methods. In a manner similar to this, an individual's understanding of their emotional quotient and level of emotional maturity has important educational and societal ramifications for both their own well-being and those of society. Teachers who have grown emotionally are capable of managing their emotions. They develop the essential self-awareness to be conscious of their emotions and be able to analyse and express them. Every student has always relied heavily on their emotionally capable teachers for their achievement in life. The efficiency of one's teaching talents is really improved by emotional maturity, which is one of the essential elements of teaching competency. Teachers need to be emotionally mature in the current climate because it helps them be better teachers.

Need and Importance of the Study

In this day of globalisation, our educational system must adjust to meet the requirements of the students. Teacher educators need to be emotionally mature enough to impart material to fully developed future teachers. The need for this study is crucial given that many aspiring teachers must cultivate recognisable attitudes and acceptable emotional maturity. Our ability to have life experiences that we can control does not depend on our emotional and mental well-being. We must confront the emotions and circumstances that are a part of life because we are human. In order to meet the demands of the Prospective teachers, the present study will improve their teaching skills, which will also improve their understanding of the subject, their excitement for it, their attitude towards children, and their ability to adapt. In order to achieve their objectives for knowledge, competence, and attitude, aspiring teachers must pay close attention to their emotional side.

In order for future teachers to be successful throughout their pre-service training and once they begin teaching, it is crucial to improve their emotional maturity and teaching competence coping mechanisms. To assist practising teachers in moving along their chosen professional route, enhance the quality of education, and thus assure the advancement of quality teaching, a better degree of performance, skillfulness, classify awareness, and performance is required. The purpose of this study is to address the pressing necessity and significance of providing teachers with the information they need in order to lead their students' adept learning towards better levels of performance. The study includes recent research that was conducted for the fieldwork.

Objectives of the Study

- To find out the level of emotional maturity of Prospective teachers.
- To find out the level of teaching competency of Prospective teachers
- To find out whether there is any significant difference among Prospective teachers in their emotional maturity with regard to the background variables namely:
- Gender (Men and Women) (ii) Educational Qualification (UG and PG),
- To find out whether there is any significant difference among Prospective teachers in their teaching competency with regard to the background variables namely: (i) Gender (Men and Women), (ii) Educational Qualification (UG and PG),
- To find out whether there is any significant relationship between teaching competency and emotional maturity of Prospective teachers.

Method of Study

A normative survey approach served as the study's methodology. The Teaching Competency Scale (TCS), which the researcher created, standardised, and validated, and the Emotional Maturity Scale (EMS), which Harsangeet Kaur (2019) produced and developed. 350 prospective teachers enrolled at the college of education in the Tiruvannamalai district were used as a sample for the researcher's data collection. The distribution of the study tools followed a random sample procedure.



**Tholkappian and Sheeba****Hypothesis of the Study**

RH1: There is no significant difference between male and female Prospective teachers in their emotional maturity.

RH2: There is no significant difference between UG and PG Prospective teachers in their emotional maturity

RH3: There is no significant difference between male and female Prospective teachers in their teaching competency.

RH4: There is no significant difference between UG and PG Prospective teachers in their teaching competency.

RH5: There is no significant relationship between teaching competency and emotional maturity of Prospective teachers

Analysis of Data

Table 1 shows that 26% of prospective instructors had high emotional maturity, 45.7% had average emotional maturity, and 28.3% had low emotional maturity.

According to Table 2, whereas 27.2% of prospective teachers had a high level of teaching competency, 47.4% and 25.4% of prospective teachers had average and poor levels of teaching competency.

RH1: There is no significant difference between male and female Prospective teachers in their emotional maturity.

Table 3 shows a significant difference in emotional maturity between male and female prospective instructors, with a P value of less than 0.001. Thus, the emotional maturity null hypothesis is disproved at a 1% level.

RH2: There is no significant difference between UG and PG Prospective teachers in their emotional maturity

With a P value of less than 0.001, Table 4 demonstrates a significant difference in emotional maturity between prospective instructors with UG and PG diplomas. The null hypothesis about emotional maturity is thus rejected at a 1% level.

RH3: There is no significant difference between male and female Prospective teachers in their teaching competency.

With a P value of less than 0.001, Table 5 demonstrates a significant difference in the levels of teaching competency of male and female prospective teachers. The null hypothesis regarding teaching competency is thus rejected to a level of 1% as a result.

RH4: There is no significant difference between UG and PG Prospective teachers in their Teaching competency

Table 6 demonstrates a significant difference in teaching competency between prospective teachers with UG and PG degrees, with a P value of less than 0.05. As a result, the teaching competency null hypothesis is disproved at a 5% level.

RH5: There is no significant relationship between teaching competency and emotional maturity of Prospective teachers

According to the findings in Table 7, there is a significant positive correlation between prospective teachers' teaching proficiency and emotional maturity. Consequently, the null hypothesis was disproved.

Findings

- The level of emotional maturity of Prospective teachers was average.
- The level of teaching competency of Prospective teachers was average
- There was significant difference between male and female Prospective teachers in their emotional maturity. While comparing the mean scores, female Prospective teachers were rated higher than male Prospective teachers in their emotional maturity.
- There was significant difference between UG and PG Prospective teachers in their emotional maturity. While comparing the mean scores, PG Prospective teachers were rated higher than UG Prospective teachers in their emotional maturity
- There was significant difference between male and female Prospective teachers in their Teaching Competency. While comparing, female Prospective teachers were rated higher than male Prospective teachers in their emotional maturity.
- There was significant difference between UG and PG Prospective teachers in their Teaching Competency. While comparing, PG Prospective teachers were rated higher than UG Prospective teachers in their emotional maturity





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➤ There was significant positive relationship between teaching competency and emotional maturity of Prospective teachers.

Recommendations and Implications

The following recommendations are made in light of the findings:

- To help future teachers understand the significance of emotional maturity, awareness campaigns, seminars, and discussions on emotional instability, emotional regression, poor social adjustment, lack of independence and flexibility, and adoptability may be done.
- A lot of chances might be made available to the future teachers to assist them in taking part in different social activities. To cultivate social values in potential teachers, outreach activities like NCC, Scouts and Guides, etc., may be run
- In order to foster emotional maturity and the fundamental teaching skills in prospective teachers, it is important to grow their feeling of independence. This can be done through counselling and supervision.

CONCLUSION

It is said that educators are the ones who build the next generation. They can act as guides for pupils as they go through the process of education for development. Students learn well in the cognitive, affective, and psychomotor domains when a teacher performs well and is proficient in their teaching methods. Similar to other professionals, educators must possess the requisite emotional maturity and commitment to their career in order to provide teaching. Both actual performance skills and theoretical knowledge are necessary for professional-level competence in teaching. The interaction- and interpretation-based approach to teaching and learning can only become relevant and effective through the strict application of key skills. A teacher with the right emotional maturity level might also encourage a pupil to explore their creative side. The study of "emotional life" among teachers is increasingly developing as a descriptive discipline equivalent to anatomy, and this is widely acknowledged. The results of the current study showed a strong correlation between prospective teachers' emotional maturity and their teaching proficiency. This confirms that in order to interact with the matured prospective teachers who must develop recognisable attitudes and suitable emotional maturity in them, teacher educators who convey information and knowledge must possess a well-balanced emotional maturity. The current study will assist future instructors in realising the value of emotional maturity and teaching competency in enhancing their professional performance. Therefore, it is essential to raise teaching competency and emotional maturity in aspiring teachers so that they can confidently guarantee teaching effectiveness both during their pre-service programme and after becoming teachers. This will effectively raise the quality of instruction and, as a result, greatly raise standards of learners.

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Table 1: Level of Emotional Maturity of Prospective teachers

Low		Average		High	
N	%	N	%	N	%
98	28.3	161	45.7	91	26

Table 2: Level of Teaching Competency of Prospective teachers

Low		Average		High	
N	%	N	%	N	%
90	25.4	165	47.4	95	27.2

Table 3. Mann- Whitney test for significant difference between Mean Rank of male and femaleprospective teachers' overall emotional maturity

Gender	Mean Rank	Z value	P value	Result
Male (N = 154)	114.21	9.712	P<0.001**	S
Female (N=196)	221.86			

Table 4. Mann- Whitney test for significant difference between Mean Rank of UG and PG prospective teachers' overall emotional maturity

Qualification	Mean Rank	Z value	P value	Result
UG (N = 222)	158.11	3.821	P<0.001**	S
PG (N=128)	203.69			

Table 5. Mann- Whitney test for significant difference between Mean Rank of male and female prospective teachers' overall teaching competency

Gender	Mean Rank	Z value	P value	Result
Male (N = 154)	124.23	8.241	P<0.001**	S
Female (N=196)	215.32			

Table 6. Mann- Whitney test for significant difference between Mean Rank of UG and PG prospective teachers' overall teaching competency

Qualification	Mean Rank	Z value	P value	Result
UG (N = 221)	161.76	3.044	P<0.05*	S
PG (N=129)	198.51			





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Table 7 Relationship between Teaching Competency and Emotional Maturity of Prospective teachers

Correlations		Overall Emotional Maturity	Overall Teaching Competency
Overall Emotional Maturity	Pearson Correlation	1	.725**
	Sig. (2-tailed)		.000
	N	350	350
Overall Teaching Competency	Pearson Correlation	.725**	1
	Sig. (2-tailed)	.000	
	N	350	350
**. Correlation is significant at the 0.01 level (2-tailed).			

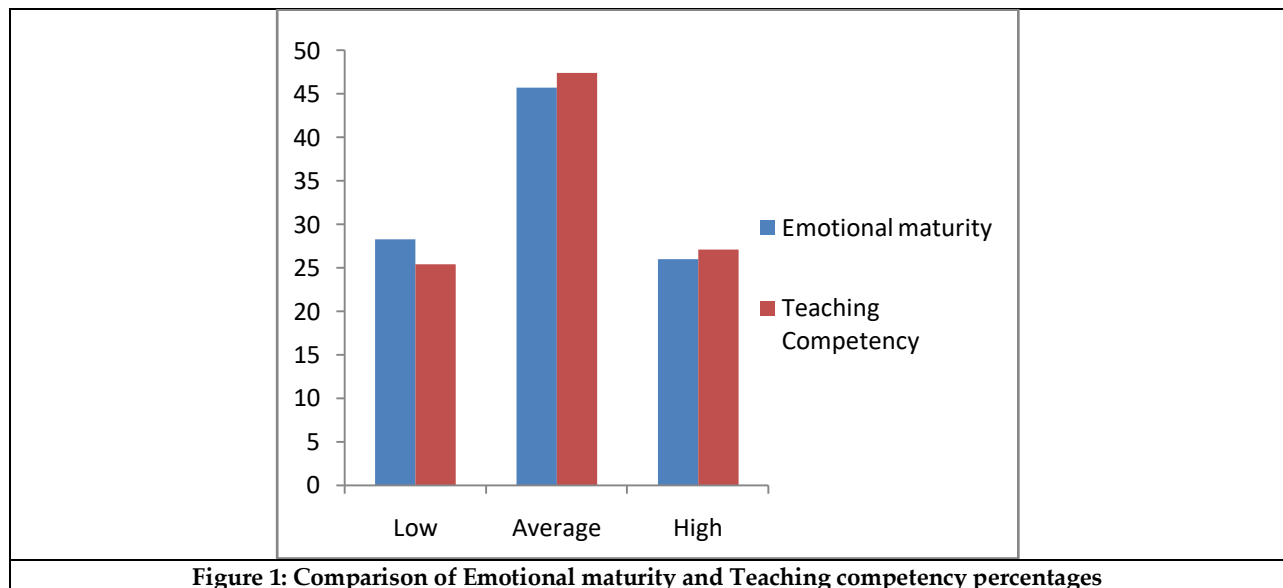


Figure 1: Comparison of Emotional maturity and Teaching competency percentages





The Impact of Women Empowerment in Accelerating Gender Equality and Economic Development

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ABSTRACT

The Indian Constitution has enshrined Gender Equality in the preamble. The United Nations Sustainable Development Goal 5 promotes achieving Gender Equality. Given the above two, this paper discusses how women-led development fosters achieving SDG 5. This paper discusses the need for empowering women and the contribution of women to the economic development of the nation. The paper lists various government initiatives to empower women that act as a tool to achieve SDG 5 – gender equality. The paper establishes the link between the accomplishments of SDG 5 and other sustainability goals. The paper shows how the empowerment schemes have accelerated the holistic development of women. The article concludes that women are key drivers of inclusive growth, and positive transformative behavioral changes have strengthened the status of women in India. The collaborative efforts of government, institutions, and communities can bring sustainable development for all and give the future what women want.

Keywords: The paper lists various government initiatives to empower women that act as a tool to achieve SDG 5 – gender equality.

INTRODUCTION

Women in India constitute 48.4% of the population. The need to develop women in all spheres has been paramount. The history of Women's empowerment dates back to 1917 when the demand for their political rights was put forth. Articles 14 and 15 of the Indian constitution emphasize gender equality and equal opportunity for women. The



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recent women's reservation bill was an epic stand that leaped politically empowering women. Globally, too, women are facing gender issues, and India is not an exception. Rural and urban Indian women face challenges concerning basic amenities, access to quality health and education, and equal remuneration and recognition. Out of 17 SDGs, the United Nations has considered Gender Equality its 5th vital goal to achieve and empower all women and girls. Currently, women contribute 18% of India's GDP. According to the McKinsey Global Institute report, if India can bridge the gender gap and provide equal opportunity for women, it may increase their contribution towards GDP by 30%, which can be remarkable. India ranks 142 out of 146 countries according to the World Economic Forum Global Gender Report 2023 about equal opportunity and economic participation of women. This is by far woeful in a country that has an exclusive ministry working for the development of women with so many policies and schemes rolled out to empower women. Given this, the recent G20 presidency summit held in New Delhi focused on enhancing Economic and Social Empowerment, bridging the Gender Digital Divide, driving Gender-Inclusive Climate Action, and securing Women's Food Security, Nutrition, and Well-Being. This aligns with the objectives of United Nations SDG5 and acts as a driving force in the overall development of women. The recent G20 presidency emphasized women's education and health and empowered women at the grassroots levels. Implementing various schemes has helped to see visible results in empowering women at all levels, fostering women's leadership and decision-making in local governance. Institutional, government, community, and working groups' participation plays a significant role in achieving gender equality. Promoting gender equality is imperative to unlock women's power and create a sustainable and resilient world. Women are undoubtedly agents of change, provided empowerment and gender equality are revisited through the lens of inclusivity. Gender egalitarianism must be promoted to achieve a just and equitable society for everyone.

REVIEW OF LITERATURE

Prof. Seema Singh and Dr. Antra Singh (2020) examined how India has prepared itself to achieve SDG 5. The paper also discusses various government initiatives currently focussing on women's empowerment. They conclude that to achieve SDG5, the programs must be altered accordingly. **Dr. Manju Tembhre (2018)** says that even though women contribute to nearly 50% of the population, there are growing concerns about providing women with basic facilities. Some women are still facing issues globally concerning violence, insecurities, rape, and other injustice in society. All these factors are the hindrances to their empowerment. **Sanjay Kumar Ghadai & Satya Narayana Misra (2019)** discuss the umbrella schemes of government in empowering women. Women's development in education, health, politics, and decision-making is discussed in detail. **Dr. Sriparna Guha & Samrat Goswami (2006)** describe the importance of gender budgeting in amplifying the concept of women empowerment. Gender budgeting is part of the Union budget, which allocates funds to women-specific and pro-women schemes in all spheres. It helps in filling the gender gaps and empowers women. **Luigi Guiso and Luana Zaccaria (2023)** highlight the effect of gender parity on household decisions. This paper provides the basis for identifying gender and social norms as to who controls the family's financial decisions, whether male or female. **Amanda Keddie (2022)** this article identifies critical issues of gender equality and social justice. It suggests how gender inequality can be addressed through policing organizations.

OBJECTIVE

1. To study the role of women as a game changer for inclusive growth.
2. To assess the impact of women empowerment schemes in accelerating gender equality and economic development.

RESEARCH METHODOLOGY

This conceptual study is based on data available on authenticated websites, government reports, research papers, working papers, and scholarly articles.



**Sharada and Nirmala****WOMEN - GAME CHANGER FOR INCLUSIVE GROWTH**

Inclusive growth, by definition, means economic growth that creates equal opportunities in areas of education, health, and employment opportunities to reduce poverty. Gender responsiveness is a vehicle for achieving this. To affirm women as game changers for inclusive growth, it is essential to identify the barriers within the system and help them overcome them. In this regard, The United Nations Conference on Trade and Development (UNCTAD) agenda for 2030 aims to leave no one behind.

NEED FOR WOMEN'S EMPOWERMENT

To achieve SDG5 gender equality, the primary focus must be women's empowerment. Empowered women mean an empowered nation. She contributes to families' health, productivity, and well-being, contributing to better communities and developing an improved society. Women need to be socially, economically, politically, and legally empowered. Women are less paid compared to men and deprived of access to education and health. In this context, educating women enables them to become the voice of this silent revolution. A positive transformative behavioral change helps strengthen a woman's inherent power. An educated woman is more informed regarding the labor market and social security systems and to speak up for themselves without becoming the victim of injustice. The rise in the trend of entrepreneurial mindset among women has reflected upon the exponential growth in women-led businesses. With this, they can significantly contribute to the economy of the nation. According to the survey report by Bain and Company and Google, women entrepreneurs in India are expected to create 150-170 million jobs by 2030. Women entrepreneurs bring different perspectives, innovations, and ideas and foster economic growth. They are emerging in women-centric businesses, such as beauty, wellness, health, hygiene, maternity, childcare, fashion, fitness, etc. These business opportunities have helped woman identify their skill and talents.

WOMEN EMPOWERMENT AND ECONOMIC DEVELOPMENT

Women's empowerment has been recognized as an essential factor in the economic development of any society. Empowering women through various means can lead to increased economic growth, poverty reduction, and overall development of society. Women's empowerment is also essential to achieve gender equality, a fundamental human right. In many parts of the world, women have been historically marginalized and deprived of equal opportunities in education, employment, and access to resources. However, with increased awareness and efforts by governments, civil society, and other stakeholders, there has been a significant shift towards empowering women to participate more actively in economic activities.

1. Women empowerment can lead to economic development in several ways. Firstly, it can lead to increased productivity and efficiency. Women empowered through education and training can bring new ideas, skills, and perspectives to the workforce. They can also contribute to the development of businesses, thereby increasing the economy's overall productivity.
2. Secondly, women's empowerment can lead to increased economic growth. When women have access to resources such as credit, land, and other means of production, they can start their businesses and create employment opportunities for themselves and others. This, in turn, leads to increased economic growth as more people are engaged in productive economic activities.
3. Thirdly, women's empowerment can lead to poverty reduction. Women who are empowered can increase their income, leading to better living standards for themselves and their families. They can also invest in their children's education and health, which can break the cycle of poverty and lead to a more prosperous future.
4. Fourthly, women's empowerment can lead to better health outcomes. When empowered, women can also make better decisions about their and their families' health. This can lead to better health outcomes for themselves and their families, reducing the burden on the healthcare system.
5. Finally, women's empowerment can lead to more excellent stability. When women are empowered, they are more likely to participate in community decision-making. This can lead to a more peaceful and prosperous society.



**Sharada and Nirmala****WOMEN EMPOWERMENT SCHEMES ACCELERATING GENDER EQUALITY**

The government has launched several schemes and programs to increase the participation of women in various income-generating and economic activities, such as the Pradhan Mantri Mudra Yojana, Stand Up India, and the National Rural Livelihood Mission. The impact of these initiatives can be seen in the increased participation of women in economic activities. For example, India's number of women entrepreneurs has increased significantly in recent years. According to a report by the National Sample Survey Office, the percentage of women entrepreneurs in India increased from 14 percent in 2011 to 12 percent and 20 percent in 2015 to 16. According to a statistical report by the International Labour Organization, women's labor force participation rate in India increased from 23.5 percent in 2004-05 to 31.2 percent in 2019-20.

WOMEN EMPOWERMENT SCHEMES

These schemes give women access to quality education and health, promote entrepreneurship, facilitate employment, and ensure safety and security. The practical implementation of these schemes will bring a 360-degree change in the development of women.

HOLISTIC DEVELOPMENT OF WOMEN THROUGH SCHEMES

The Self Help Groups, Microfinance, micro-credit, and Direct Benefit Transfers brought a paradigm shift in economic empowerment among women, addressed issues of poverty and lack of credit funds, and provided financial assistance to undertake income-generative activities. The schemes Beti Bachao Beti Padoo encouraged enrollment of girl children by providing good quality education and access to decent school infrastructure. The school dropouts were significant because of the unavailability of toilet facilities, and this scheme addressed this issue effectively. The re-enrollment of girls back to school increased after the implementation of this scheme. Access to quality healthcare, nutrition, and well-being of women, especially pregnant women and lactating mothers, is higher on the agenda. The World Health Organization, in its 67th session on the status of women held recently, focused on improving women's and girl's health through technology and digital innovations. Nirbhaya projects and stop centers were established to ensure the safety and security of women. One Stop Center was established to provide free legal assistance to women who are victims of violence. The main objective of this scheme is to lend psycho-social support to women who are victims of rape, violence and social injustice.

FOSTERING GENDER EQUALITY THROUGH WOMEN'S EMPOWERMENT

Promoting gender equality is a fundamental human right and foundation for building a peaceful, prosperous, and sustainable nation. The impact of women empowerment schemes shows how far we have progressed in achieving gender equality. Gender bias, wage discrimination, lack of access to primary education, health, and decent jobs, violence, and discrimination are the significant challenges women face globally. There is a persistent gap between men and women; government initiatives play a pivotal role in arresting these issues. The socially constructed roles for men and women are barriers to achieving equality.

SUSTAINABLE DEVELOPMENT GOAL 5 – GENDER EQUALITY

The achievement of SDG 5 can directly contribute to accomplishing other Sustainability Goals.

CONCLUSION

Gender-based discrimination and violence are not just women's issues, but they are societal issues that require the involvement of all members of society. Men and boys can play a critical role in challenging patriarchal norms and promoting gender equality. Programs that engage men in promoting women's empowerment, such as the Menstrual Hygiene Management program, have been successful in promoting gender equality and challenging stereotypes. In conclusion, women's empowerment is a critical issue that requires a multi-dimensional approach. While progress has been made in recent years, there is still a long way to go in ensuring that women in India are fully empowered and able to participate equally in society. A comprehensive approach is needed, including policy and programmatic





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interventions. With sustained effort and investment, Gender equality can lead to more equitable and sustainable development for all.

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Table 1: Women Empowerment Schemes

SAMARTHYA	SAMBAL
Pradhan Mantri Mathru Vandana Yojana	Nirbhaya Projects
Shakti Sadans	One Stop centres
Sakthi Niwas	Women Help Line
Palna	Beti Bachao Beti Padoo

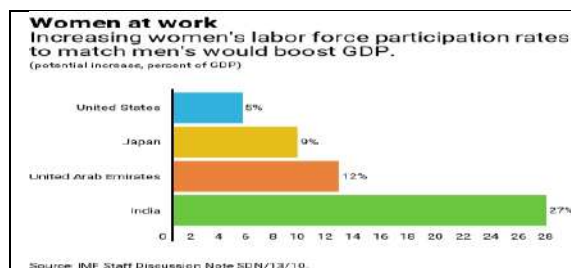


Fig 1

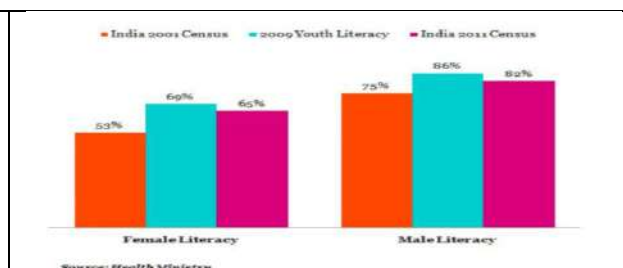


Fig 2

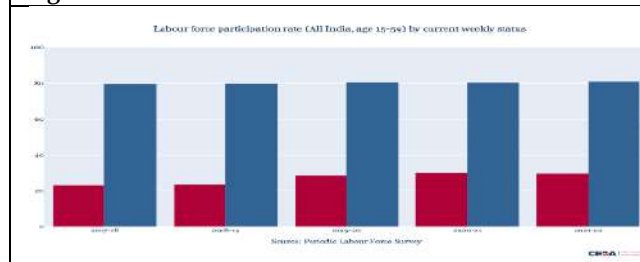


Fig 3

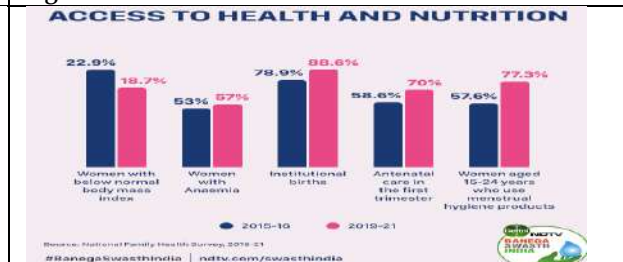


Fig 4





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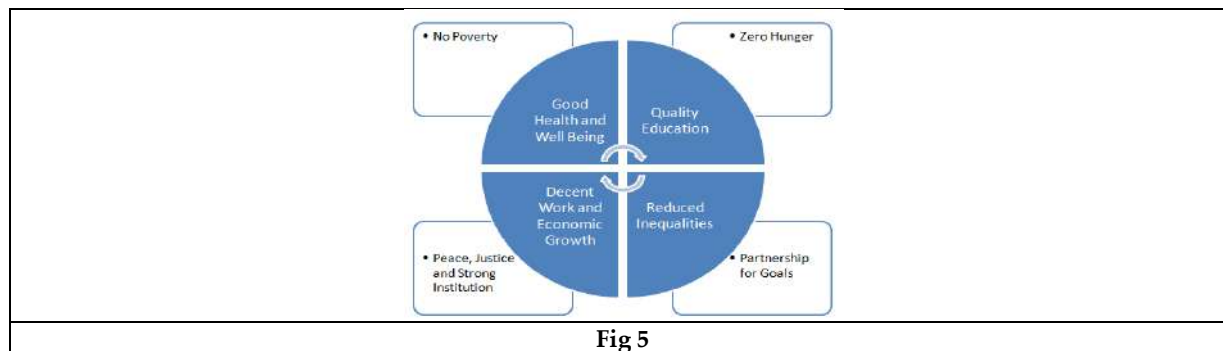


Fig 5





Anti-Oxidant Potential of *Capparis zeylanica* Fruit Extracts: *InVitro* Assessment

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ABSTRACT

In recent years, many research endeavors have focused on identifying antioxidants derived from plants in order to integrate them into conventional therapeutic approaches. By utilizing the DPPH and Reducing Power methods, we evaluated the *in vitro* anti-oxidant ability of pet. ether, methanolic, and aqueous extracts from *Capparis zeylanica* fruits. DPPH radical scavenging tests were conducted using BHA as the benchmark antioxidant, while reducing power tests used ascorbic acid as the standard reducing agent. UV-Visible spectrophotometers were used for all analyses. According to both assays, extracts obtained from *Capparis zeylanica* fruits demonstrated significant free radical scavenging and reducing power attributes in a concentration-dependent manner. The anti-oxidant properties of *Capparis zeylanica* fruits therefore make them ideal candidates for pharmaceutical applications.

Keywords: *Capparis zeylanica*, free radical, Anti-oxidant assay, DPPH, Reducing power, BHA





INTRODUCTION

An unpaired electron is the hallmark of free radicals, making them exceptionally unstable chemical entities. As a result of their instability, they extract electrons from other molecules, resulting in damage [1]. When the body goes through its normal metabolic processes, free radicals appear, playing both a negative and a positive role. Overproduction of free radicals and/or deteriorating anti-oxidant levels can result over tissue damage [2]. Through the mitigation of oxidative damage caused by reactive oxygen species (ROS) on cell components, antioxidants play a key role in protecting our bodies from diseases [3]. Studies suggest that plant-derived antioxidants possess significant therapeutic potential in conditions resulting from free radicals, including diabetes, cancer, neurodegenerative disorders, cardiovascular diseases, aging, gastrointestinal problems, arthritis, and the aging process. These antioxidants are capable of scavenging free radicals. In some cases, plant-derived remedies have fewer adverse effects than synthetic antioxidants that have exhibited toxic and potentially mutagenic properties [4]. The use of medicinal plants has long been a preferred method of treating diseases due to their novel phytoconstituents and their low adverse effects. Among the 252 approved cancer drugs, 11% come from plants, according to the World Health Organization [5]. There is a wide distribution of *Capparis zeylanica* Linn., which belongs to the Capparidaceae family, in India, China, Nepal, Bangladesh, Malaysia, and Pakistan. Several conditions such as dysentery, diabetes, and rheumatism can be treated with its leaves [6]. An in vitro study demonstrated that *Capparis zeylanica* roots ethanol and methanol extracts exhibit notable antioxidant properties [7]. Among its many properties, the leaves act as an immunostimulant [8], an antidepressant [9], and an antimicrobial [10]. Among the many functions of antioxidants within the body is to delay or prevent the oxidation process that free radicals initiate within it. In order to identify natural antioxidants in *Capparis zeylanica* fruits, we conducted in vitro antioxidant assessments.

MATERIALS AND METHODS

Collection and Authentication

From the nearby region of Tirumala hills, Andhra Pradesh India, we obtained the botanical specimen of *Capparis zeylanica*. Fruits were cleaned, and then air dried for four weeks under shade. A fine powder was then obtained by blending the dried fruits, preserving them in an airtight container, and marking them for further research.

Crude Extract Preparation

The fruit powders were successively extracted using pet ether (80%), methanol (90%), and distilled water (10 cycles). Using a rotary evaporator, the extracts were concentrated under reduced pressure and temperature for further analysis. Afterward, the extracts were stored in an airtight container in a refrigerator below 10°C. Methanol solutions were prepared by dissolving pet ether, methanol, and aqueous extracts in it.

Screening of Preliminary Phytochemicals

In order to identify the phytoconstituents in *Capparis zeylanica* fruits, preliminary phytochemical analysis was conducted using pet. ether, Methanolic, and aqueous extracts. A variety of phytochemical compounds were tested using standard methods. The results were observed in the table 1.

Chemicals Used

A local supplier provided DPPH (Diphenyl picryl hydrazyl), BHA (Butylated Hydroxy Anisole), ascorbic acid, potassium ferricyanide, FeCl₃, tris HCl buffer, phosphate buffer, and TCA (Trichloro-acetic acid).





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In vitro Anti-Oxidant Assay

DPPH free radical scavenging assays and the reducing power method were used to evaluate the anti-oxidant potential of the plant extracts. There was a wide range of concentrations of extracts in ethanol, varying from 10 mg/ml to 40 mg/ml. A triplicate assessment was conducted, and the average value was used.

Diphenyl Picryl Hydrazyl Assay

The Samples were tested for DPPH scavenging activity following the prescribed methods [11,12]. There was a combination of plant extracts in 0.2 ml of methanol solution with varying concentrations (10 to 40 µg/ml). After mixing this solution with tris HCl buffer, 0.8 ml of it was added to the amalgamated solution. The buffer solution had a concentration of 100 mM and a pH of 7.4. Once the buffer solution was incorporated, 1.0 ml of DPPH solution was introduced at a concentration of 500 mM in methanol. As a follow-up, the resultant mixture was vigorously shaken for 30 minutes and allowed to air dry. A UV-Visible Spectrophotometer (Systronics 117, Japan) was used to determine the absorbance of the resultant sample at 517 nm. For accuracy and consistency, each experiment was repeated three times. A methyl alcohol solution prepared from *Capparis zeylanica* fruits was used for the blank reference volume of 0.2 ml. In the control experiment, 500 mM of DPPH was dissolved in methanol with a volume of 1 ml. To compare the results of this methodology, a standard antioxidant known as BHA (butylated hydroxy anisole) was used.

Using the following procedure, we determined the DPPH scavenging activity:

$$\% \text{ DPPH radical scavenging assay} = \frac{\text{Control absorbance} - \text{Sample absorbance}}{\text{Control absorbance}} \times 100$$

DPPH radical scavenging activity was more potent when absorbance of the reaction mixture was reduced. *Capparis zeylanica* fruit extracts were obtained through pet. ether, methanol, and aqueous methods in this study.

Reducing Power Assay [13,14]

A volume of 1.0 ml of methanolic plant extract solution containing 100–200 mg/l of extract was combined with 2.5 ml of phosphate buffer at a concentration of 0.2 M and pH 6.6. Potassium ferricyanide ($\text{K}_3\text{Fe}(\text{CN})_6$) was added at a concentration of 10 g/l to this mixture. A 20-minute incubation was performed at 50°C on the amalgamated solution. Mixture was treated with trichloroacetic acid prepared at a concentration of 100 g/l following incubation. For 10 minutes, the mixture was centrifuged at 3000 rotations per mins. An equal volume of distilled water and 0.5 ml of ferric chloride at a concentration of 1 g/l were blended with 2.5 ml of the supernatant solution. Using a UV-Visible Spectrophotometer, we measured the absorbance of the resulting solution at 700 nm. The standard solution contained 2.5 ml of ascorbic acid at a concentration range of 5 to 10 mg/ml, while the control solution was phosphate buffer solution. As a blank, 1.0 ml of methanolic plant extract solution was used. It is indicative of increased reducing power when the absorbance of the reaction mixture increases [15].

Statistical Findings

Based on three independent determinations, results are presented as mean + standard error of the mean (SEM). One-way analysis of variance (ANOVA) was used to assess differences between groups. It was determined that statistical significance was reached at a significance level of $P < 0.05$.

RESULTS AND DISCUSSION

According to Table 1, extracts obtained from the fruits of *Capparis zeylanica* contain Alkaloids, Glycosides, Flavonoids, Carbohydrates, Saponins and Tannins. Utilizing the DPPH radical scavenging assay and the reducing power technique, these plant extracts were assessed for their in vitro antioxidant potential. According to Table 2, various fruit extracts obtained from *Capparis zeylanica* as well as BHA have been shown to be DPPH radical scavengers. Table 3 highlights the reducing properties of *Capparis zeylanica* fruit extracts and ascorbic acid. More absorbance results more reducing ability. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$ (vs control), $n=3$. There has been remarkable antioxidant efficacy demonstrated by *Capparis zeylanica* fruit extracts. Aqueous, methanolic, and pet ether extracts have shown considerable effectiveness compared to the benchmark standard anti-oxidants BHA and ascorbic acid, based on both



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assessment methods. Anti-oxidant assays using DPPH rely on DPPH's ability to lose its color when exposed to anti-oxidants. Due to the unpaired electron within the DPPH radical, there is a distinctive absorbance at 517 nm and a visible purple hue. Analyzing changes in absorbance can quantify the amount of decolorization caused by anti-oxidant substances contributing electrons to DPPH radicals. As potent anti-oxidants, all fruit extracts obtained from *Capparis zeylanica* suppress DPPH activity in a significant and dose-dependent manner.

Typically, reductants influence a compound's ability to reduce. By providing a hydrogen atom, these reductants interfere with free radical chains, which have demonstrated antioxidative properties. These reductants, or anti-oxidants, found in the fruit extracts of *Capparis zeylanica* facilitate the reduction of the Fe^{3+} /ferricyanide complex, resulting in its transformation into iron (Fe^{2+}) through reduction. Using Perl's Prussian blue, as a reaction product, this conversion allows monitoring Fe^{2+} levels at 700 nm [16]. Reducing potentials of *Capparis zeylanica* fruits extracts were significant, and these potentials showed a positive correlation with sample quantity. There are similarities between this study and previous studies [17]. As a result, both the DPPH radical scavenging assay and the reducing power assessment showed significant anti-oxidant activity in the *Capparis zeylanica* fruit extracts. The anti-oxidant potential of methanolic extracts was the highest among these extracts. Phytochemical compounds within the plant are likely responsible for these anti-oxidant effects, as indicated by this study [18].

CONCLUSION

In light of the results obtained from this study, the methanolic extract of *Capparis zeylanica* fruits enriched with substantial amounts of phytoconstituents, such as flavonoids and tannins, demonstrated remarkable scavenging and reducing power attributes that outperformed pet ether and aqueous extracts. *In vitro* studies indicate that this particular plant extract provides significant anti-oxidant benefits, which may be used to combat various oxidative stress conditions. In spite of this, it remains unknown what specific constituents confer antioxidative efficacy. The anti-oxidant compounds inherent in the plant extracts need to be isolated and characterized in more detail. It is also essential to evaluate this extract's anti-oxidant potential *in vivo* before considering clinical applications.

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Table:1 Screening of Preliminary Phytoconstituents

Phytoconstituents	Pet ether extract	Methanolic extract	Aqueous extract
Alkaloids	+	+	+
Glycosides	+	+	+
Flavonoids	+	+	+
Carbohydrates	+	+	+
Saponins	+	+	+

+ Present of phytoconstituents

Table: 2 DPPH radical scavenging activity of various extracts of *Capparis zeylanica* fruit

Concentration	Pet ether extract				Methanolic extract				Aqueous extract			
	OD 517 nm		% anti-oxidant		OD 517 nm		% anti-oxidant		OD 517 nm		% anti-oxidant	
	S	Std	S	Std	S	Std	S	Std	S	Std	S	Std
10µl	1.101	1.011	20.89*	33.29*	1.101	1.021	21.30*	27.58*	1.120	1.111	20.48*	21.87*
20 µl	1.132	0.981	25.31*	36.04*	1.102	0.920	22.05*	34.61*	1.031	0.871	27.37*	38.37*
30 µl	1.101	0.899	27.50*	40.42*	0.929	0.549	34.09	60.71**	0.989	0.540	30.42*	61.48**
40 µl	1.002	0.749	34.03*	50.16**	0.559	0.448	59.74**	67.55**	0.751	0.381	46.07*	72.24***

S- sample; Std-standard; *p<0.05; **p<0.01 and ***p<0.001

Table: 3Reducing power assay of various extracts of *Capparis zeylanica* fruit

Sample	Concentration	Absorbance (700nm)	% anti-oxidant activity
Sample 1			
• Control	0	0.07	-
• Pet ether extract	100	0.41	80.00***
	150	0.87	89.00***
• Ascorbic acid (standard)	200	1.13	92.00***
	5	0.84	90.00***
	10	1.02	91.00***
	15	1.33	93.00***



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Sample 2			
• Control	0	0.08	-
• Methanolic extract	100	0.64	85.00***
	150	0.78	87.60***
• Ascorbic acid (standard)	200	0.89	91.53***
	5	0.87	88.59***
	10	0.96	90.00***
	15	1.20	92.00***
Sample 3			
• Control	0	0.10	-
• Methanolic extract	100	0.64	81.75***
	150	0.92	87.00***
• Ascorbic acid (standard)	200	1.01	88.00***
	5	0.98	87.18***
	10	1.02	88.00***
	15	1.21	90.00***





Optimization of Tribological Properties of AA 7075-T6 alloy using Taguchi and MARCOS Approaches

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ABSTRACT

Usage of lightweight materials with better tribological characteristics is significantly increasing in industrial applications. Current research work is focusing on to optimize the tribological properties of AA 7075 alloy which is widely used in many industries because of its high strength to weight ratio. Strength of this alloy is further increased using T6 heat treatment process. This heat treated alloy is widely used where highly machined parts are required. Tribological properties like wear rate (WR) and coefficient of friction (COF) of AA 7075-T6 are found using pin-on-disk apparatus. Initially, a L9 orthogonal array as per Taguchi method is used to design the number of experiments. To optimize the tribological properties in the present research work multi criteria decision making (MCDM) method MARCOS is used which was developed in the year 2020. Moreover, a simple and very effective ENTROPY method is used to calculate the weights of wear rate and coefficient of friction in the above MCDM method. The utility function value obtained through MARCOS method is optimized for larger- the better criteria using Taguchi method and found the optimal conditions of smaller WR and COF. The result shows that MARCOS method coupled with Taguchi has been provided 83% increase in WR and 36% decrease in COF.

Keywords: Tribological properties, AA 7075-T6, Taguchi, ENTROPY, MARCOS





INTRODUCTION

7000 and 6000 grade alloys of aluminium are widely used in several applications because of their high strength to weight ratio and very good resistance to corrosion property. Density of Aluminium is 2.7 g/cm³ which is very low compared to the density of steel which is 7.87 g/cm³. Aluminium alloys of these series are lighter, almost one third of steel. In 7075 alloy, zinc is the major alloying element as shown in table 1. Strength of AA 7075 alloy is further increased by T6 heat treatment process, which is widely used for parts with high strength and explosion proof parts or highly machined parts. T6 heat treatment process involves solutionizing, quenching and artificially aging. Heat treated Aluminium 7075-T6 alloy's toughness and specific strength are almost equal to certain steels. Apart from this, aluminum alloys have good economic value and relatively cost-effective when compared to steels [1-4]. As this material is widely used in highly machined parts, finding the optimum tribological properties is very much required. The current study is aimed to find the optimal settings during the tribological performance of AA7075-T6 alloy which is acting as pin and sliding against a pin-on-disk testing machine and the disk is made up of stainless steel. Wear behaviour of the specimen is studied by measuring the wear of the worn surface specimens and coefficient of friction values are recorded by the tester during the experiment. Low contact loads and small sliding velocities are selected intentionally to eliminate the thermal influence during experimentation. Various researches have conducted experiments on AA7075 alloy reinforced with Silicon carbide, boron carbide, CNTs, graphene and Titanium carbide and reported improvement in wear properties of AA7075 alloy with these reinforcements [5-9]. Much work is not reported on the wear behavior of AA7075-T6 alloy (Tempered 7075 aluminum alloy with zinc as major alloying element). Hence this investigation is carried out to find the optimum conditions for better wear and coefficient of friction of this alloy using Taguchi method and other popular MCDM methods [10-12]. Thermal Dry Sliding Wear Performance of Wrought AA 7075-T6 is studied by Mehmet Cevizet.al [13]. Prakash kumar et.al studied the Effect of T6 Heat Treatment on Mechanical and Tribological Properties of Fabricated AA7075/ZrB₂/Fly Ash Hybrid Aluminum Metal Matrix Composite [14]. Optimization studies on wear behaviour of this alloy-based metal matrix composite is studied by various researchers [15-16].

MATERIALS AND METHODOLOGY

Materials

AA7075-T6 (heat-treated) alloy in the form of rods are used to find the optimum levels of the properties like wear and coefficient friction in this research work. Various elements present in this AA7075-T6 alloy are presented in the table 1.

Wear Test

An instrument which will monitor and measure the friction and wear is used to find the dry sliding wear behavior. 8 mm diameter and 30 mm height standard wear pin specimens are prepared from the above AA7075(T6) alloy and polished metallographically for wear test. Experiments are conducted by varying the parameters like load, sliding distance and sliding velocity. These three factors are varied at three levels. Taguchi's Design of experiment is selected to perform the experiments. As per Taguchi method, L9 orthogonal array is used and nine experiments are conducted by varying applied load at 10, 20, and 30 N and sliding velocity at 1.57, 2.09 and 2.61 m/sec and sliding distance of 1000, 2000 and 3000 meters. At all these nine levels, coefficient of friction and wear rate are calculated using the wear testing machine. In table 2, the experimental results are presented.





RESULTS & DISCUSSION

As per Taguchi design, the responses coefficient of friction and wear rate both are to be as small as possible for optimization of Static Problems. Signal to Noise ratio for smaller the better characteristic is calculated using the formula(1) given below

$$S/N \text{ ratio} = -10 \log(\Sigma(Y^2)/n) \quad (1)$$

Where no. of repetitions is n and response value is y.

Optimization of Wear Rate

L9 array design is given in table 3.

Main effects plot of signal to noise ratios of wear is shown in Fig.1. It is observed from fig.1 that load at level1, sliding velocity at level 3 and sliding distance at level 1 are optimum for low wear rate. Ranking of the three factors on wear rate is shown in Table 4. Predicted mean wear rate at the optimum levels is calculated as per Taguchi methodology and found to be 0.4146.

Prediction of mean values of wear and S/N ratio are given in table 5.

Optimization of Coefficient of Friction:

L9 array design is given in table 6 and ranking of factors on coefficient of friction are presented in table 7. Main effects plot is shown in fig.2 and predicted COF is 1.05275 and shown in table 8.

Prediction of mean and S/N of coefficient of friction are given in table 8.

MCDM Methods

To find best alternative for both small wear rate and coefficient of friction MCDM (Multi Criteria Decision Making) methods are used. To address the complex real time problems MCDM methods are widely used. These are used by the decision makers especially when more than one criterion is involved. In this research work, we have selected two recently developed methods and compared their results with experimental results. First step in using the MCDM methods is to finalize the weights for each response. There are different methods to find out the weights like AHP and Entropy. Here we have used the ENTROPY method to find the weights because of its simplicity.

Weight calculation using ENTROPY Method

Proposed by C.E Shannon in 1948. Also called as Shannon Entropy Method

Step:1 Decision matrix normalization to obtain the project outcomes.

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^m x_{ij}} \quad (5)$$

Step:2 Entropy(ej) Computation using the below equation

$$e_j = -h \sum_{i=1}^m r_{ij} \ln r_{ij}, j = 1, 2, \dots, n \quad (6)$$

$$\text{Where } h = 1/\ln(m) \quad (7)$$

Step:3 Based on the concept of entropy, objective weights are defined

$$w_j = \frac{1-e_j}{\sum_{j=1}^n (1-e_j)}, j = 1, 2, \dots, n \quad (8)$$

Weightage of wear rate is 0.46 and weightage of Coefficient of Friction is 0.54





MARCOS Method

In 2020, Zeljko Stevic proposed Measurement Alternatives and Ranking according to Compromise Solution (MARCOS) method. In the beginning, this method was used to find a viable supplier assortment in the healthcare industry. Ali edabi Torkayesh *et al* [17] used this method for the selection of landfill location in cities. This method consists of below steps

Step 1: Decision-making matrix development and an extended decision-making matrix containing the ideal solution.

$$= \begin{bmatrix} x_{IS1} & x_{IS2} & \dots & x_{ISj} \\ x_{11} & x_{12} & \dots & x_{1j} \\ x_{21} & x_{22} & \dots & x_{2j} \\ \dots & \dots & \dots & \dots \\ x_{i1} & x_{i2} & \dots & x_{ij} \\ x_{AIS1} & x_{AIS2} & \dots & x_{AISj} \end{bmatrix} \quad (9)$$

Where, IS = max xij for benefit and min xij for cost; AIS = min xij for benefit and max xij for cost

Step 2: Normalization of the extended initial matrix by applying equation (10) and (11):

$$n_{ij} = x_{ij}/x_{is} \quad \text{for benefit} \quad (10)$$

$$n_{ij} = x_{is}/x_{ij} \quad \text{for cost} \quad (11)$$

Step 3: Calculation of the weighted matrix, where weight coefficients of the criterion w_j is calculated using AHP method [9-13].

$$v_{ij} = n_{ij} \times w_j \quad (12)$$

Step 4: Utility degree computation of alternatives k_i (equations 13 and 14).

$$k_i^+ = \frac{S_i}{S_{ISi}} \quad (14)$$

Where S_i ($i = 1, 2, \dots, m$) epitomizes the addition of elements of the weighted matrix v

$$S_i = \sum_{j=1}^n v_{ij} \quad (15)$$

Step 5: Computation of utility function of alternatives $f(k_i)$

$$f(k_i) = \frac{k_i^+ + k_i^-}{1 + \frac{1-f(k_i^+)}{f(k_i^+)} + \frac{1-f(k_i^-)}{f(k_i^-)}} \quad (16)$$

Where $f(k_i^+)$ is the utility function on the subject of ideal solution, while $f(k_i^-)$ is the utility for function on the subject of anti-ideal solution (Equations 17 and 18).

$$f(k_i^+) = \frac{k_j^+}{k_i^+ + k_i^-} \quad (17)$$

$$f(k_i^-) = \frac{k_j^-}{k_i^+ + k_i^-} \quad (18)$$

Highest $f(K_i)$ obtained is 0.0480 which is ranked 1 and it is the Experiment No.1.

Taguchi method is used to maximize the $f(K_i)$ value using the Larger-the better criteria. S/N ratios for larger-the better criteria are calculated using the formula given below (Equation 19) and main effects plot is shown in fig.3

$$S/N \text{ ratio} = -10 \log_{10} \left(\frac{1}{n} \sum_{i=1}^n \frac{1}{y_i^2} \right) \quad (19)$$

Response Table for Signal to Noise Ratios is given in table 7.

Prediction values as per MARCOS method are shown in table 8.

Above setting is Experiment No. 3 of Taguchi design.

Among the three different settings of load, sliding velocity and sliding distance (10,2.61,1; 10,2.61,2 and 10,2.61, 3) suggested by most of the methods, the last setting of experiment (10, 2.61,3) is already conducted as part of Taguchi L9 orthogonal array which is experiment number 3. Remaining two sets of experiments (10, 2.61,1 and 10,2.61,2) are conducted and found the wear rate and coefficient of friction values. The results are tabulated in the table12.





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CONCLUSIONS

Many researchers used different MCDM methods to optimize tribological properties of different materials. Uttam Kumar Sahoo et. al [18] studied the tribological properties using Taguchi coupled WASPAS method. Dinesh Shinde et. al [19] compared different MCDM methods like TOPSIS, EDAS, MOORA and VIKOR for determining optimal settings of manufacturing process parameters for two friction materials used in automotive brakes. Different weighting methods were studied by Tej Singh et.al [20]. Here we have attempted to study the tribological properties of AA-7075-T6 alloy using Taguchi coupled, newly developed MARCOS method with entropy weighting method.

From the results comparison table 12, it can be concluded that

1. MARCOS MCDM method along with Taguchi method could not improve the optimization function $f(K_i)$. There is 0.05% decrease in the function $f(K_i)$.
2. Experiment No.3 is satisfying the both the criteria of wear rate and coefficient of friction with weightages of 0.46 and 0.54 respectively, as suggested by Taguchi method for optimization of coefficient of friction and MARCOS MCDM method coupled with Taguchi method.
3. MARCOS MCDM method is very effective in taking the right decisions when more than two deciding factors are involved with appropriate weightages.

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Table 1. Weight % of AA7075 alloy composition.

S.No.	Element	Composition % in AA7075
1	Magnesium	2.4
2	Manganese	0.06
3	Titanium	0.07
4	Copper	1.5
5	Silicon	0.08
6	Ferrite	0.24
7	Chromium	0.20
8	Zinc	5.8
9	Aluminum	Remaining

Table 2. Wear and Coefficient of friction values

S.No	Applied Load (N)	Sliding Velocity (m/s)	Sliding distance (kilo meters)	Wear Rate (mm ³ /m)	Coefficient of Friction
1	10	1.57	1	0.70106474	1.883
2	10	2.09	2	1.2267788	2.277754
3	10	2.61	3	1.28519687	1.196419
4	20	1.57	2	3.68033649	5.956882
5	20	2.09	3	2.2198855	5.204497
6	20	2.61	1	2.10304942	5.357789
7	30	1.57	3	5.95864003	8.981911





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8	30	2.09	1	7.36067298	9.190862
9	30	2.61	2	2.50508237	7.690329

Table 3. Taguchi Orthogonal Array for wear test

Taguchi orthogonal Array	L9(3 ³)
Factors	3
Runs	9

Table 4. Ranking of factors on wear rate.

Level	Load	SV	SD
1	-0.2900	-7.9120	-6.9035
2	-8.2338	-8.6801	-7.0232
3	-13.6059	-5.5376	-8.2030
Delta	13.3160	3.1425	1.2995
Rank	1	2	3

Table 5. Prediction of wear

S/N Ratio	Mean
2.02203	0.414673

Table 6. Taguchi orthogonal array for coefficient of friction

Taguchi Array	L9(3 ³)
Factors	3
Runs	9

Table 7. Ranking of factors on coefficient of friction

Level	Load	SV	SD
1	-4.735	-13.355	-13.115
2	-14.803	-13.582	-13.456
3	-18.684	-11.285	-11.651
Delta	13.950	2.296	1.806
Rank	1	2	3

Table 8. Predicted mean and S/N of coefficient of friction

S/N Ratio	Mean
-2.18993	1.05275





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Table 9. Ranking of factors as per MARCOS

Level	Load	SV	SD
1	-27.54	-35.83	-35.15
2	-36.74	-36.31	-35.43
3	-41.24	-33.39	-34.95
Delta	13.70	2.92	0.47
Rank	1	2	3

Table 10. Prediction of mean and S/N ratio for MARCOS method

S/N Ratio	Mean
-25.5313	0.0474247

Table 11. Settings recommended as per MARCOS method

Load	SV	SD
10	2.61	3

Table 12. Results comparison of various MCDM methods

	Taguchi (Wear Rate)	Taguchi (CoF)	MARCOS	MARCOS with Taguchi
Criteria	Smaller the better	Smaller the better	Max. $f(K_i)$	Larger the better
Levels suggested for (Load, sliding velocity, and sliding distance)	10, 2.61, 1 (Not part of L9 array)	10, 2.61, 3 (Exp.No.3)	10, 1.57, 1 (Exp. No.1) $f(K_i) = 0.048$	10, 2.61, 3 (Exp. No.3)
Predicted value	0.414673	1.05275	NA	$f(K_i) = 0.04742$
Experimental values	0.435865	1.196419	Wear rate: 0.70106474 CoF: 1.883	Wear rate: 1.285196 CoF: 1.196419
Improvement of Function	NA	NA	NA	- 0.05%
Change in wear rate	NA	NA	NA	83.3%
Change in CoF	NA	NA	NA	- 36.46%





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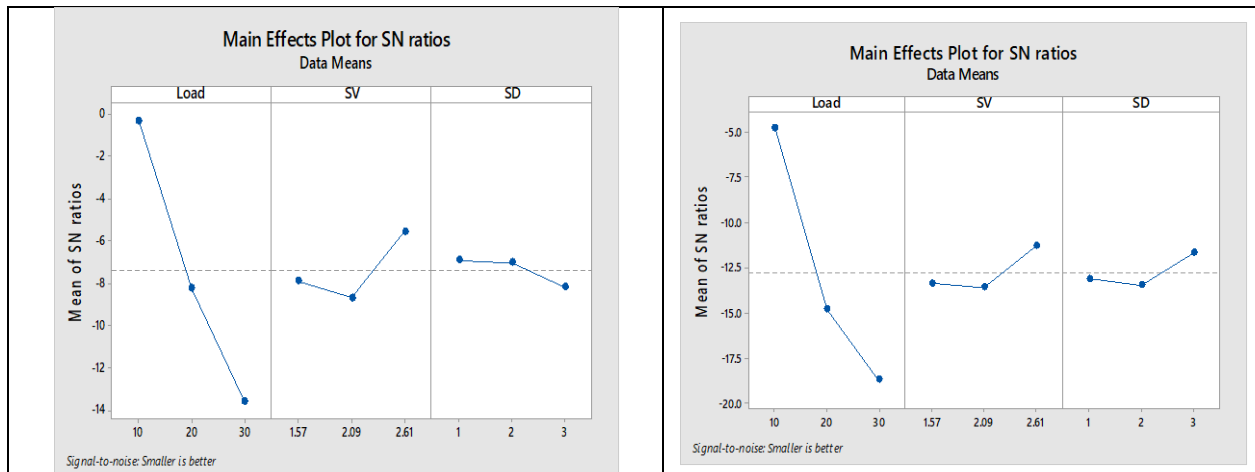


Figure1. Main effects plot for wear rate.

Figure 2. Main effects plot for coefficient of friction

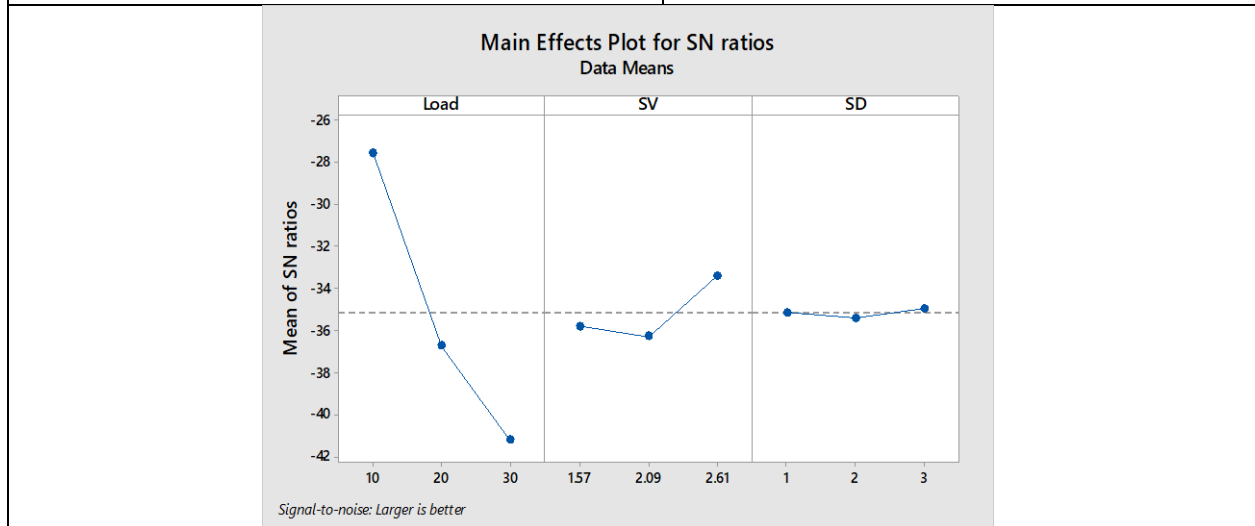


Figure 3. Main effects plot for MARCOS





Advancing Drug Abuse Testing: Analytical Techniques, Innovations, and Challenges

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ABSTRACT

Abuse of drugs screening is a vital component of the public's safety and health, detecting and preventing substance usage in a variety of areas. This review presents an in-depth examination of the term, its significance, and its uses in healthcare, employment, law enforcement, and rehabilitation for addiction. It highlights the magnitude of the opioid pandemic and the critical role of accurate analytical techniques. The article delves into misused drug categories such as opioids, stimulants, depressants, hallucinogens, and cannabinoids, as well as upcoming developments such as synthetic substances and changing cannabis policies. It delves deeply into analytical procedures such as immunoassays, chromatography, spectroscopy, and molecular biology while emphasizing their significance in reliable drug identification. For program credibility, method validation, regulatory conformity, quality control, and certifications are essential. False results and ethical considerations are presented as difficulties. Applications are investigated in clinical, workplace, athletics, forensic, epidemiological, and therapeutic environments,



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with a focus on healthcare, safety, equitable competition, legal proceedings, public wellness, and treatment for addiction. Finally, the essay discusses developments in analytical methodologies, AI integration, portable testing equipment, and the necessity to handle emerging drug trends and difficulties. Drug abuse testing is still an important tool in combatting addiction to substances and creating healthier, more secure societies.

Keywords: Drug Abuse Testing, Analytical Techniques, Opioid Epidemic, Immunoassays, Artificial Intelligence, Point-of-Care Testing.

INTRODUCTION

Drug abuse screening is critical in protecting the safety and health of society by identifying illegal or improper drug usage in a variety of settings(1). It is an essential component of programs for healthcare, occupational safety, criminal justice, and addiction treatment(2). This review paper looks into the diverse world of drug misuse testing, providing light on its meaning and significance, the looming opioid crisis, and the vital role that reliable and precise analytical procedures play in addressing that worldwide issue(3).

Definition of Drug Abuse Testing

The analytical examination of biological specimens like urine, blood, hair, saliva, or sweat in order to identify the presence of drugs or their metabolites is referred to as drug misuse testing, which is also known as screening for drugs or toxicological testing(4). The primary goal is to detect if a person has recently been abused or been subjected to drugs of abuse, such as opioids, stimulants, depressants, hallucinogens, and cannabinoids. These tests can also detect developing designer medications, helping to govern and regulate products(5).

Significance and Purpose of Drug Abuse Testing

Misuse of drug testing is important in many areas, including healthcare, employment, security forces, and rehabilitation for addiction(6). It assists doctors in identifying and monitoring substance use disorders, designing treatments, and guaranteeing the protection of patients who are administered controlled pharmaceuticals in the healthcare industry(7). Screening for drugs in the workplace enhances both security and efficiency, especially in industries where intoxication can lead to incidents, such as transport and construction also aids in parole and supervised release monitoring in the criminal justice system, and also aids individuals on the road to recovery in addiction rehabilitation programs(8).

Overview of the Opioid Epidemic and Other Drug Abuse Concerns

The opioid crisis is now recognized as one of the most serious drug addiction crises in recent history, characterized by the widespread adoption of opioid medicines such as prescription pain relievers and illegal opioids such as heroin and fentanyl(9). It has resulted in an increase in fatal overdoses, strained healthcare systems, and broken up many families. Further illicit substance problems, aside from opioids, include the misuse of Amphetamine benzodiazepines, and synthetic cannabinoids(10).

Importance of Accurate and Reliable Analytical Techniques

The precision and dependability of the methods of analysis used determine the success of drug misuse testing(8). False benefits and drawbacks can have far-reaching implications, damaging people's lives and their livelihoods(11). As a result, it is critical to use cutting-edge analytical procedures such as immunoassays, chromatography, spectroscopy, and molecular biology approaches. To achieve precision and accuracy, these approaches go through extensive verification methods(12).



**Reshma et al.,****Types of Drug tested**

These classifications include an extensive variety of compounds, each with its own set of effects and hazards. In this component, we will look at the most common types of illicit substances that are examined on a regular basis, along with current developments that deserve our attention(13).

Categories of Abused Drugs

Opioids: In many areas of worldwide, opioid misuse has reached pandemic proportions. These medicines, which include conventional pain relievers like oxycodone as well as illegal ones like heroin, can cause addiction, overdose, and death. Analytical approaches are critical to tracking opioid usage and detecting cases of misuse(14).

Stimulants

Stimulant medications, such as amphetamines and cocaine, are well recognized for increasing energy, awareness, and happiness. Their overuse, on the other hand, can lead to addiction, cardiovascular problems, and psychological difficulties. Stimulant testing is essential in a variety of circumstances, including employment or athletics doping regulation(15).

Depressants

Sedative withdrawal symptoms of depressant medications, such as benzodiazepines and barbiturates, on the nervous system of the body. They are frequently recommended for anxiety and sleep difficulties, but their soothing effects can lead to misuse. Analytical procedures are used to identify drug abuse and overdose(16).

Hallucinogens

LSD and psilocybin (found in magical mushrooms) are hallucinogenic substances that change perception, thoughts, and feelings. Although they are normally less addictive, their overuse can result in psychological and behavioural disorders. In forensic and therapeutic contexts, testing these compounds is critical(17).

Cannabinoids

Cannabis, the most widely misused cannabinoid, is now legal in many areas for medicinal and recreational use. However, abuse remains a problem, particularly among teens. Cannabinoid screenings help reveal current usage but do not measure functionality(18).

Emerging Trends in Drug Abuse

Recent developments in drug usage continue to put testing for drug skills to the test. These developments involve the usage of innovative synthetic medications (such as artificial opioids and designed stimulants) along with new modes of consumption (such as vaping) that can mask detection. Furthermore, the legalization and increasing popularity of cannabis presents new issues, as existing methods for testing may not adequately indicate impaired levels(19).

Analytical Techniques for Drug Abuse Testing:**Immunoassays**

Enzyme-Linked Immunosorbent Assay (ELISA): Immunosorbent coupled to an enzyme Assay, often known as ELISA, is a typical immunoassay method used in drug misuse testing. The primary idea underlying ELISA is that antibodies attach to antigens, such as drug metabolites or proteins linked with drug use(20). ELISA kits are used in drug misuse testing to identify the amount or concentrations of drugs or their metabolites in biological samples such as urine or blood. This extremely sensitive technology relies on colorimetric or fluorescent signals generated by enzyme reactions to provide a dependable way of drug misuse screening(21).

Radioimmunoassay (RIA)

Radioimmunoassay (RIA) is a critical method in drug misuse testing that relies on binding competition between a radiolabelled drug or its metabolite and a specific antibody(20). This approach provides highly accurate quantitative



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measurement of drug levels in biological specimens. Because of competition, fewer radio-labeled medicines bind to the antibodies as the amount of medication in the sample increases. RIA may precisely assess the presence and level of a medicine by measuring the residual bound radioactivity. This precise and targeted method has proven beneficial in healthcare and forensic contexts, assisting in the identification and tracking of illicit drug use while assuring accuracy and dependability(22).

Chromatographic Techniques

Gas Chromatography-Mass Spectrometry (GC-MS): GC-MS is a strong analytical technology that is commonly used in drug testing. It works by sorting drug molecules in a sample based on their chemical characteristics and then identifying them using mass spectrometry. GC-MS has outstanding specificity and sensitivity, making it excellent for identifying a wide variety of medicines, metabolites, and even low amounts in biological materials(23). Its precision and dependability aid in the accurate determination and measurement of substances, which is critical for establishing substance abuse in clinical, forensic, and occupational situations(24).

Liquid chromatography-mass spectrometry (LC-MS)

LC-MS is an important analytical method used in testing for drugs. It allows for the accurate determination and quantification of drugs and their by-products in biological samples like urine and blood(25). The specificity, as well as sensitivity of LC-MS, of LC-MS, are unrivalled, allowing for the identification of a wide range of misused compounds such as opioids, stimulants, and cannabis(26). Its capacity to offer quantifiable data assists in evaluating drug concentrations, verifying usage, and tracking progress with therapy, making LC-MS a critical tool in the battle against substance addiction and the health hazards that come with it(27).

Spectroscopy-Based Methods

UV-Vis Spectroscopy:UV-Visible spectroscopy is a flexible analytical method used to identify and quantify drugs or their metabolites in drug abuse testing. It is based on molecules' absorption of ultraviolet (UV) and visible (Vis) light, which gives information about their electrical structure. UV-Vis spectroscopy is useful in drug analysis for identifying and measuring chemicals with distinct absorption patterns, which aids in the identification of unlawful drugs and the evaluation of drug purity(28).

Infrared (IR) Spectroscopy

In illicit drug testing, infrared spectroscopy is used to study the molecular structure of drugs. It quantifies the absorption of infrared rays by chemical bonds in molecules, revealing functional groups and overall composition. By comparing spectra to reference databases, IR spectroscopy is used to identify medicines and related substances. It assists forensic and analytical chemists in determining the presence of certain drugs and determining the purity of seized substances, hence aiding enforcement operations to curb drug misuse(29).

Molecular Biology Techniques

Polymerase Chain Reaction (PCR) in Drug Abuse Testing

Polymerase Chain Reaction (PCR) is a basic molecular biology method that is widely used in drug screenings. The basic idea behind it is to amplify certain DNA sequences. In this context, PCR aids in the identification of genetic markers or variants linked to drug metabolism, addiction sensitivity, or drug responsiveness(30). PCR allows for the controlled replication of DNA sections, making it possible to discover drug-related genetic features in a person's genome. This information can be extremely useful in predicting a person's proclivity for drug usage, examining pharmacogenetics variables, and designing treatment options. The precision and receptivity of PCR have transformed personalized healthcare and pharmacogenomics, making substantial contributions to the field of drug misuse as well as treatment(31).

Next-Generation Sequencing (NGS) for Designer Drugs

Next-Generation Sequencing (NGS) is a cutting-edge genetic technique that has found innovative uses in the fight against drug addiction, notably with synthetic substances. The key reason for employing NGS in this situation is its



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capacity to quickly sequence and determine the genetic makeup of new and upcoming designer medicines(32). NGS allows forensic and criminal justice organizations to more easily categorize and monitor these compounds by analyzing their genomic information, assisting in the discovery and prevention of new psychoactive chemicals. This technology aids in staying ahead of the ever-changing world of synthetic drugs, improving the effectiveness of law enforcement operations and public safety(33).

Point-of-Care Testing (POCT)

Rapid Immunoassays

Because of their speed, simplicity, and efficacy, rapid immunoassays are an important component of point-of-care drug misuse testing. These tests use immune reactivity principles to identify particular drug metabolites or antigens in a biological sample, often urine or saliva. The urinary dipstick test, for example, exploits antibody-antigen interaction to deliver quick findings. Those assays, when used in drug misuse testing, provide rapid detection of common drug classes such as opioids, amphetamines, and cannabinoids. While they are useful for preliminary screening, they may lack the sensitivity and specificity required for conclusive confirmation, necessitating subsequent laboratory-based investigation(34).

Handheld Mass Spectrometers

Handheld mass spectrometers are a game changer in point-of-care drug misuse testing, providing on-the-spot analysis with remarkable precision. These portable gadgets work on the mass spectrometry concept, ionizing and analysing chemicals inside a sample to provide very precise and quantitative findings. Handheld mass spectrometers (MS) provide real-time detection of several substances and their metabolites in diverse matrices including urine and saliva, in drug abuse screening(35). Because of their capacity to identify compounds at low concentrations, they are invaluable for confirmatory testing, avoiding the need for costly and labour-intensive laboratory analysis. As a result, these technologies are revolutionizing the efficiency and accuracy of point-of-care drug testing, especially in emergencies and medical centres when quick choices are required(36).

Hair and urine analysis

Hair and urine testing are important procedures for identifying drug addiction. Drug residues are absorbed into hair strands over time in hair analysis, providing a historical record for drug usage. Because urine testing reveals current drug metabolites, it is a popular option for employment and clinical examinations(37).

Saliva Testing

Saliva testing is a non-invasive technique for detecting recent drug usage. It detects metabolites of drugs in oral fluids, indicating recent ingestion and the possibility for impairment. This method is very useful for roadside drug inspection and rapid on-site tests(38).

Sweat Patch Testing

Sweat patch testing is applying a patch to the skin for a lengthy period of time to collect perspiration. It has the ability to identify drug usage over a period of days to weeks, making it valuable for tracking abstinence in recovery programs and parole circumstances(39).

Emerging Technologies and Trends

Microfluidic Devices

Microfluidic devices are a game-changing tool in the field of drug misuse testing. These innovative technologies excel at downsizing and automating complex analytical operations. They function in minuscule channels, enabling the exact modification of fluids on a microscale, allowing for rapid and accurate sample handling. What makes microfluidics so intriguing in drug testing is their capacity to dramatically reduce sample sizes, accelerate analysis procedures, and improve mobility, making them ideal for testing at the point of care settings. These devices have demonstrated their worth in detecting a wide range of compounds, especially drugs of violence, and have consistently provided dependable and accurate findings in a variety of testing scenarios(40).



**Reshma et al.,****Nanotechnology in Drug Testing**

Nanotechnology has brought about a paradigm change in the field of drug misuse testing, particularly by increasing sensitivity and specificity to previously unheard-of levels. This game-changing discipline makes use of nanomaterials such as nanoparticles and nanosensors, which are painstakingly designed to detect even trace amounts of pharmaceuticals within biological specimens. Their exceptional surface area-to-volume ratio allows for rapid and efficient binding while also allowing for considerable signal amplification, resulting in exceptionally sensitive tests. Beyond diagnostics, nanotechnology has pioneered medication delivery technologies, allowing for controlled-release formulations and the possibility of precisely targeted therapy to address problems with substance abuse. As a result, it promises pioneering and imaginative solutions to the complicated problems faced by drug usage(41).

Artificial Intelligence for Data Analysis

Artificial intelligence (AI) is now recognized as a key factor in drug misuse testing, revolutionizing how we interpret and analyze data. AI algorithms are now capable of filtering through large datasets created by diverse analytical approaches, recognizing subtle patterns, identifying abnormalities, and revealing significant trends in the consumption of drugs thanks to their remarkable data-crunching skills. The use of machine learning algorithms improves the accuracy and efficiency of drug testing by significantly lowering false positives and improving prediction accuracy. Furthermore, AI-driven solutions provide vital aid in decoding complex test findings, assisting clinicians and forensic investigators in making well-informed choices linked to the diagnosis and administration of drug usage(42).

Method Validation and Regulatory Considerations**Importance of Method Validation**

To assure the accuracy, precision, and reliability of analytical procedures, validation of methods is critical in drug abuse testing. It ensures that the approach adopted is appropriate for the task at hand, reducing erroneous findings and maintaining the reliability of testing programs(43).

Regulatory Guidelines and Requirements (e.g., FDA, WHO)

The FDA and WHO, for example, have strict criteria and procedures for drug misuse testing. These principles serve to assure the quality and integrity of testing methods by ensuring uniformity, standardization, and conformity with defined standards(44).

Quality Control and Assurance

Quality control and assurance measures are fundamental to drug abuse testing. They involve the implementation of rigorous processes and standards to monitor and maintain the accuracy and reliability of analytical methods, preventing errors and ensuring consistent results(45).

Accreditation and Certification of Laboratories

Drug abuse testing requires accreditation and certification programs. Laboratories that follow recognized certification criteria exhibit expertise and dependability, creating trust in the accuracy and validity of their testing methods and outcomes(46).

Challenges and Limitations in Drug Abuse Testing(47)**False Positives and False Negatives**

False positives occur when a test wrongly detects drug usage, perhaps leading to unintended consequences. False negatives, on the other hand, lead to missed identification, allowing drug usage to go undetected while diminishing faith in testing systems.



**Reshma et al.,****Detection Windows and Half-Life of Drugs**

Because of the varied half-lives of the medications, their detection window differs. Short-acting medicines may be overlooked if tests are performed too late, but long-lasting drugs may provide incorrect results if tests are performed too early.

Cross-Reactivity and Specificity

Cross-reactivity refers to a test's reaction to substances that are structurally identical to the target medication, which might result in negative results. The specificity in screening is critical for reducing such mistakes.

Matrix Effects and Sample Preparation

Complex matrices in biological samples (urine, blood, saliva) can interfere with drug testing. Adequate the collection of samples is critical for removing impurities and guaranteeing reliable findings.

Evolving Drug Formulations

Tests must adjust as medication compositions vary. New formulations, like as extended-release versions or innovative drug delivery mechanisms, may necessitate changes to testing methodologies to correctly identify misuse.

Ethical and Legal Issues

Testing for drug misuse presents ethical and legal considerations, such as privacy, consent, and possible prejudice. Balancing the necessity for testing with the fundamental liberties and dignity of persons is a continuing concern in drug misuse prevention.

Applications of Drug Abuse Testing**Clinical Drug Testing**

The application of analytical methods in clinical drug testing entails monitoring patients' compliance with prescribed prescriptions, detecting illegal drug usage, and managing substance misuse problems. Reliable measurement of medicines and metabolites in biological fluids assists healthcare practitioners in making educated treatment decisions and maintains patient safety(48).

Workplace Drug Testing

Workplace drug testing uses analytical techniques to screen personnel and maintain a drug-free atmosphere in the workplace. Urine and saliva testing, chain of custody methods, cut-off levels, and confirmation tests employing techniques such as GC-MS and LC-MS to validate positive results are all key aspects of ensuring workplace safety and integrity(49).

Sports Doping Control

Analytical methods are critical in sports doping control because they detect illegal drugs (e.g., anabolic steroids, and stimulants) in athletic samples. Rigid testing protocols, anti-doping rules, target, and non-target analysis employing GC-MS and LC-MS, and the need to collect collecting samples integrity to ensure equal competition are all discussed(50).

Forensic and Legal Drug Testing

In legal contexts, forensic and legal drug testing utilizes analytical procedures to offer proof of drug usage or impairment. The chain of control, adherence to legal norms, the use of particular and sensitive assays, and expert testimony to support investigations into crimes, probationary monitoring, and court processes are all key themes(51).

Epidemiological Studies

Analytic tools are used in epidemiological research to acquire population-level data on drug misuse trends and patterns. Selection at random, survey layout, specimen collection, and the use of quantitative tests are all concepts.



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This data is used to support public health policies, and preventative efforts, and develop policies in the fight against substance misuse(52).

Drug Rehabilitation Programs

Analytical testing is used in drug recovery programs to measure patients' progress in eliminating substance misuse. Frequent urine or saliva tests to assess prohibition, adherence to treatment, and relapse identification are key principles. These findings drive therapy modifications and help people get back on track(47).

Future Directions and Innovations

Advances in Analytical Techniques

Analytical methods advancements are revolutionizing drug misuse testing. Techniques such as liquid chromatography-mass spectrometry (LC-MS) and high-resolution mass spectrometry allow for more exact drug and metabolite identification. This improves sensitivity, specificity, and detection of novel psychoactive drugs, placing testing for drugs at the cutting edge of substance addiction control(53).

Integration of Artificial Intelligence and Machine Learning

The combination of machine learning with artificial intelligence is improving the evaluation of drug misuse testing data. These methods can handle large datasets quickly, which improves result comprehension, pattern identification, and anomaly detection. They improve the precision of detecting drug usage and forecasting developing patterns, providing testing for drugs more proactive and effective(54).

Portable and Wearable Drug Testing Devices

Drug testing technologies that are portable and portable are becoming more widely available. These instruments, which frequently include microfluidics and biosensors, enable immediate testing in a variety of scenarios, ranging from roadside drug tests to remote healthcare. They provide continuous tracking capabilities, which improve convenience and allow for immediate intervention in drug misuse instances(55).

Emerging Drug Trends and Challenges

It is critical to keep up with evolving pharmacological trends and issues. Analytical procedures must adapt to identify these compounds properly when new medications and consumption methods emerge. To address the evolving environment of drug usage and its related consequences, researchers and developers must remain watchful and proactive(56).

CONCLUSION

Finally, drug misuse testing is critical to protecting public health and improving safety in a variety of industries. The ongoing advancement of analytical techniques, bolstered by the incorporation of artificial intelligence and the introduction of portable screening devices, represents a watershed moment in our ability to identify and manage substance abuse. These advancements enable us to not only precisely identify a greater range of compounds but also to do so quickly and efficiently. These breakthroughs present a ray of optimism in a world befuddled by the intricacies of growing drug trends and shifting behaviors regarding consumption. They envision a future in which proactive identification and intervention may help reduce the devastation caused by substance misuse, building a healthier and safer society for all.

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CONFLICT OF INTEREST

The authors do not have any conflict.

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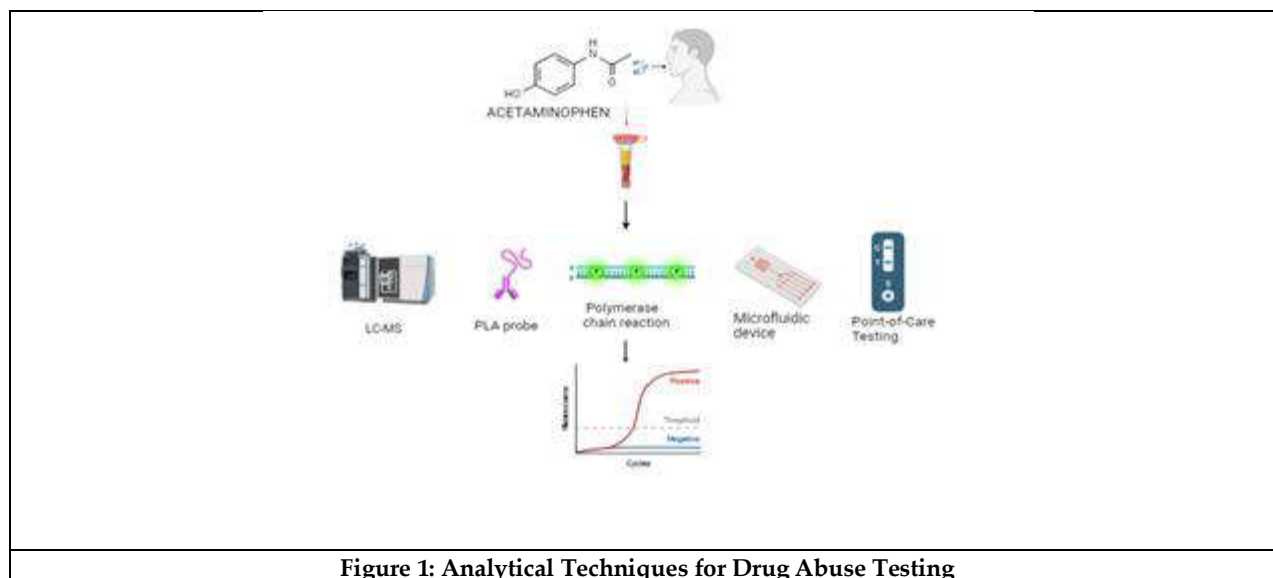


Figure 1: Analytical Techniques for Drug Abuse Testing





An Investigation into Surface Logistics Procedures at a Subset of Chennai's Automobile Companies

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ABSTRACT

Logistics could have been more present in the past when it came to storage and transporting materials by truck or train. Global industrial networks have expanded due to the swift developments in information technology and international transportation across all nations. These days, information transmission is crucial for proper logistics concerning payments, customs paperwork, and the location and status of moving merchandise. Transportation of goods, information, and money across international borders is known as logistics, and it necessitates a highly developed national infrastructure, including ports, airports, the Internet, and other facilities connected to finance and IT.

Keywords: Storage, Augmentation, Recently, Infrastructure

INTRODUCTION

Logistics seeks to achieve more differentiation in their service offerings in addition to cost reduction. The success of today's top players in the market, such as Cisco, Dell, Wal-Mart, and Toyota, is primarily due to their better operational and logistical capabilities. Additionally, a few of the winning nations have built top-notch physical infrastructure, like ports and airports, as well as top-notch IT infrastructure. India is aggressively luring investments by adopting the Supply Chain Cluster Paradigm, which considers all supply chain participants, including manufacturers, financial institutions, logistics providers, etc.





REVIEW OF LITERATURE

Fowkes et al. (2017) performed study in the UK and discovered many additional reasons why delays in freight transit might lead to irregular travel times, apart from traffic. Forty respondents—who may be shippers, truckers, or operators of third-party logistics—were asked questions. Route timings varied as a result of three distinct kinds of delays to freight transit: (1) longer journey times with fixed departure times; (2) a wider range (or spread) of arrival times with fixed departure hours; and (3) a delayed schedule with effectively pushed-back departure dates. A cross-sectional assessment of companies in three industries—freight forwarding, third-party logistics service providers, and air and sea transportation—was carried out by Lai et al. (2004). The main finding of their article was that "...cost-related performance criteria are "non-integrated" and neglect chances for chain-wide performance enhancement." A systems approach should be considered when establishing criteria for measuring supply chain effectiveness, claims Holmberg (1994). Rather, several aspects such as time, speed, agility, flexibility, quality, and productivity should be included in the evaluation of supply chain performance. In this work, Aaronson et al. (2000) claim to have created a blueprint for a course on logistics education. The functional, process, and supply chain demands are explained clearly in this template. Currently, a prototype of the template is being developed using the "gestalt" idea. It explains why the whole is more than the sum of its parts. American Railroads (2001) said that taxes have to be modified as they disproportionately punish trains over vehicles. compares taxes according on the sector of transportation. The research states that although railroads must depreciate their infrastructure maintenance and repairs for tax considerations, fuel taxes paid by trucking companies are immediately deductible and utilised for upkeep. In his 2001 study, David Jorkebrock computed the external costs associated with four distinct types of freight trains and compared them to the private expenditures that railroads incur. These personal and external expenditures are not the same as the comparable costs in the transportation sector. He found that the non-market costs of freight rail include noise, pollution, and accidents. Rail external expenses vary from 0.24 to 0.25 cents per ton-mile.

STATEMENT OF THE PROBLEM

Automobiles with advanced driver assistance systems (ADAS) need exact sensors with minimal false positive and negative rates. These requirements are typically not met by a single type of sensor; instead, a combination of several types of sensors must be utilized, considering cost as well. Using a sensor fusion system to combine the sensor outputs is a challenge; moreover, the relatively few solutions on the market typically need to be revised to connect the sensor streams in a way that considers the various sensors' advantages and disadvantages.

OBJECTIVES OF THE STUDY

1. To research the relative significance of characteristics for the product's supply chain in the automotive industry.
2. To determine the elements that drive surface logistics use for corporate operations in automakers.
3. To research how well logistics services work for automakers
4. To ascertain whether clients are satisfied with surface logistics
5. To research the difficulties the Indian logistics sector faces

SCOPE OF THE STUDY

This study focuses on Chennai-based automakers that rely on logistics service providers to run their supply chains effectively. The information or data relates to different surface logistics-related problems or procedures in this sector. The informants are those who work in a specific industry's supply chain. The study only examines surface logistics in India; multimodal logistics or other modes should be covered. Chennai-based automakers will also be considered for data collection and analysis.



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RESEARCH METHODOLOGY

UNIVERSE

The term "universe" describes the study's population. Since the research is focused on logistics firms, the population of the study will consist of all logistics companies together. The study's universe will include all of Chennai's logistics firms. Big, medium, and small industries are all included.

SAMPLE SIZE

In this research, a sample size of fifteen logistics businesses is taken into account.

SAMPLING METHODS

A practical sample technique was used for the research, and data from the experts of the specific logistics firm in Chennai was gathered.

DATA ANALYSIS AND INTERPRETATION

Of surface logistics firms, around 6% have been in business for more than 10 years. They are further separated into three age groups: 26% are over 30 years old, 34% are between the ages of 11 and 20, and 34% are between the ages of 21 and 30. For more than a decade, premier surface logistics firms have been established in this manner. The majority of surface logistics firms that took part in the study are between the ages of 11 and 30. Furthermore, relatively few businesses have lately launched. In this field, it's hard for new businesses to thrive because of the established players. Table 2 shows that most companies (20 percent) are in courier services. Twenty percent of the companies are involved in transport. Almost 16 percent of companies deal with logistics solutions and 16 percent with packaging. Other services in which logistics companies participate are transport (8%) and warehouse (8%). Therefore, most companies engage in logistics services and courier services. Table 3 demonstrates that the majority of the chosen surface logistics businesses had an average yearly turnover of less than \$10 million. Given that the firms are tiny with fewer workers and offices, previous outcomes also support this.

MULTIPLE COMPARISON

Quality and reliability
Tukey HSD

MAJOR FINDINGS AND SUGGESTIONS

It has been discovered that 32% of logistics companies employ more than 300 people. Roughly 40% of logistics companies employ fewer than 100 people. Eighteen percent of the enterprises have between one hundred and two hundred employees. The remaining 10% of logistics companies employ 200–400 people. According to our data analysis, 60–70% of logistics organisations think that "supply chain benchmarking, close interaction with customers, various suppliers, and just in time supply" are beneficial strategies for supply chain management. Of the "types of systems now in use in logistics firms to support surface logistical operations," over 80% of logistics organisations choose a "custom-made system in the theory of limitations, just in time, and electronic data exchange." For "warehouse management system and customer relationships management," it was found that 50% of firms use conventional packaging and 50% of organisations regularly use custom-made solutions. Research also indicates that 60–70% of the time, companies choose "standard packaging for supply chain management, bar coding, enterprise resource planning, and supplier relationships management as well as the advanced planning system." It is found that, when it comes to "logistics companies are improving or need to improve to manage its supply chain better," system upgrades are required in more than 80% of cases, and these upgrades must take into consideration "improvement in close partnership with suppliers and in holding safety stock."





CONCLUSION

When inventory is arranged effectively to support sales, logistics creates value. Logistics costs for particular businesses usually vary from 5 to 35 percent of sales based on the company's nature, the region in which it operates, and the weight or value ratio of the inputs and goods. Usually, one of the most significant business expenses is logistics, which is only surpassed by the cost of manufacturing materials or the cost of goods sold in wholesale or retail sales. Achieving corporate objectives while striking a balance between cost expenditures and service expectations is a challenging task. The development of customer value is a universal process that all businesses must accomplish. Providing such value is crucial to attracting and keeping a devoted clientele. As a result, the current study was designed with the significance of surface logistics in the automotive industry of Chennai.

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Table.1 Establishment of Surface Logistics Companies

Year of Establishment		frequency	per cent	Valid percent	Cumulative percent
valid	Less than10 yrs	4	16	16	100
	21to 20yrs	7	28	28	28
	21to 30yrs	10	40	40	68
	More than 30yrs	4	16	16	84
	Total	2	100	100	

Table.2 Type of Surface Logistics Companies

Type of Sector		frequency	per cent	Valid percent	Cumulative percent
Valid	Shipping	2	8	8	8
	Logistics Services	4	16	16	24
	Packaging	4	16	16	40
	Logistics solution	3	12	12	52
	Warehouse	2	8	8	60
	Transportation	5	20	20	80
	Courier	5	20	20	100
Total		25	100	100	

Table 3 Turnover of the Selected Surface Logistics Companies

Yearly Turnover		frequency	per cent	Valid percent	cumulative per cent
Valid	Within 25 crores	4	16	16	16
	25-50crores	5	20	20	36
	50-100 crores	7	28	28	64
	100-200crores	3	12	12	76





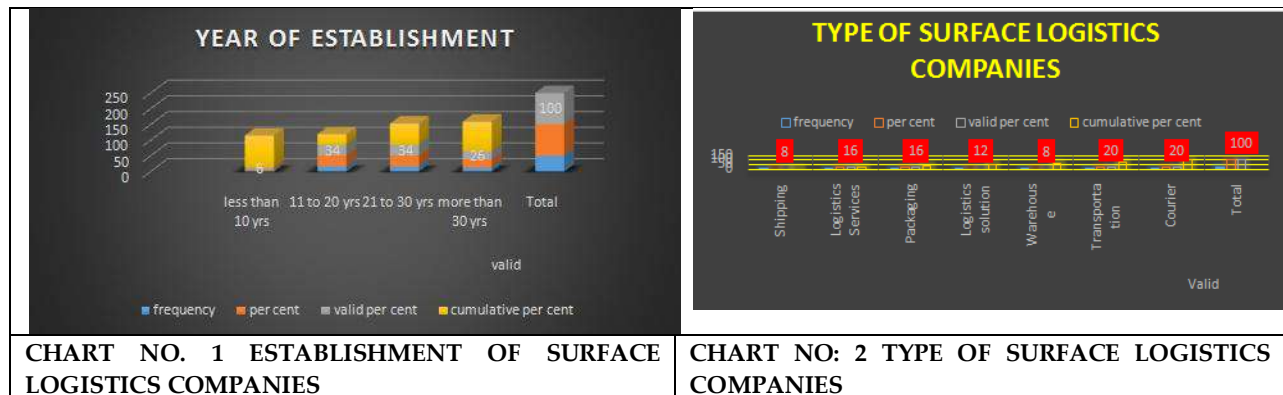
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	200-300crores	4	16	16	92
	more than 300crores	2	8	8	100
	Total	50	100	100	

Table 4 Hemogenous Subsets for Quality and Reliability variables based on the Capacity of the Container

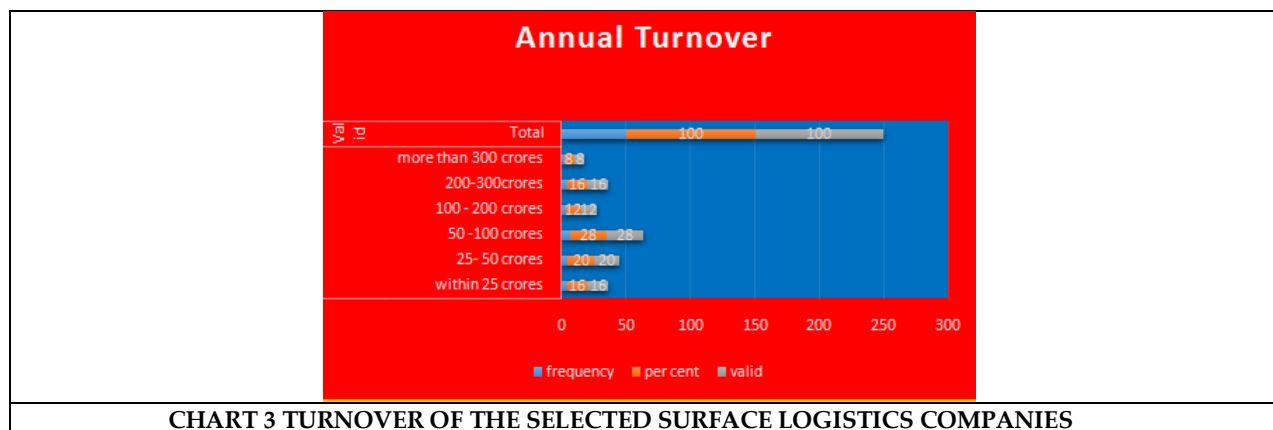
					95% Confidence Interval	
		Mean Difference (I-J)				
(I) Capacity of Container	(J) Capacity of Container		Std. Error	Si g.	Lower Bound	Upper Bound
Bulk Cargo	Piece Goods	-1.66705163*	0.343907	0	-2.66516	-0.8689471
	Half Container	-1.49079282	0.609683	0.075	-3.08296	0.1013763
	Full Container	-1.31393069*	0.343907	0.001	-2.21204	-0.4158262
Piece Goods	Bulk Cargo	1.76705163*	0.343907	0	0.868947	2.6651561
	Half Container	0.27625881	0.535941	0.955	-1.12334	1.6758536
	Full Container	0.45312094	0.183826	0.072	-0.02694	0.933178
Half Container	Bulk Cargo	1.49079282	0.609683	0.075	-0.10138	3.0829619
	Piece Goods	-0.27625881	0.535941	0.955	-1.67585	1.123336
	Full Container	0.17686212	0.535941	0.988	-1.22273	1.5764569
Full Container	Bulk Cargo	1.31393069*	0.343907	0.001	0.415826	2.2120352
	Piece Goods	-0.45312094	0.183826	0.072	-0.93318	0.0269361
	Half Container	-0.17686212	0.535941	0.988	-1.57646	1.2227327

The level of significance is 0.05 level.





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Relevance of Environmental Instruction – An Educator's Insight

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ABSTRACT

Environmental Studies involve the process of identifying principles and elucidating notions associated with the environment and its challenges, aiming to cultivate aptitudes and perspectives essential for grasping environmental intricacies. It also involves honing the skill of making informed choices and autonomously shaping ethical guidelines regarding matters pertaining to environmental well-being. Educational establishments and colleges hold a pivotal function in this endeavour by enlightening individuals across various levels, conducting inquiries, conducting impartial evaluations, and offering counsel on policy issues. This research paper thoroughly assesses the teaching methods employed in the realm of Environmental Education within the context of environmental science studies in India.

Keywords: Devising, Interdisciplinary, Ecological Interface, Individual-driven Initiative, Ecological Morality.

INTRODUCTION

Problem Statement

In the quest to leave a positive imprint on Earth, echoing the sentiments of the renowned American writer and novelist Sydney Sheldon, environmental concerns encompass a vast spectrum, embracing both the natural and societal spheres. The intricate exploration of interactions among humans, the natural environment, and social constructs forms the crux of Environmental Education. Environment represents the external biophysical framework where living organisms and humanity coexist harmoniously. In a broader context, the term 'environmental' can encompass any element, whether animate or inanimate, exerting influence on living entities. Environmental education delves into the complex network of relationships connecting individuals with their natural and human-made surroundings. This holistic field addresses vital elements such as the dynamics of population, the allocation and depletion of resources, pollution, preservation efforts, and urban/rural planning, all within the intricate framework of the human environment. Within this realm of education, various factors influencing ecosystems,



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mental and physical well-being, living and working conditions, declining urban areas, and population pressures are thoroughly explored. Environmental Education serves as a fundamental process, aiming to decipher values and clarify concepts related to the environment and its complexities. Its primary goal is to nurture essential skills and attitudes vital for a profound comprehension of the environment. This educational pursuit involves refining decision-making abilities and establishing ethical guidelines relevant to issues concerning environmental quality. The Environmental Education curriculum predominantly adopts either a multidisciplinary or interdisciplinary approach, contingent upon how concepts are organized and presented. In the interdisciplinary model, pertinent components from diverse fields converge to form a unified entity of environmental education. Conversely, the multidisciplinary model integrates thematic environmental education concepts into established disciplines, requiring meticulous coordination to ensure comprehensive coverage. Key characteristics of environmental education encompass its seamless integration into the entire formal education system at every level, its interdisciplinary nature, its holistic outlook examining ecological, social, and cultural dimensions of specific problems, its focus on practical real-life challenges, and its emphasis on cultivating a strong sense of values among learners.

Historical Background of Environmental Education

The field of environmental education, which has been around for a century, has seen a significant upsurge in various educational initiatives lately. This explosion is reflected in the wide range of books that have been published, the diverse curricula that have been adopted by educational establishments, and the rise of artistic forms like plays, movies, radio shows, and television shows, in addition to countless conferences, seminars, and numerous national and international projects. One major step forward was made in 1899 by the eminent Scottish botanist Patrick Geddes, who founded 'The Outlook Tower,' an innovative educational facility in Edinburgh, England. This institution's main goal was to improve the current surroundings while highlighting the close relationship between environmental quality and education. At the University of Keele in Germany, a turning point was reached in 2015 when environmental education was recognized as a vital component of universal education because of its great teaching potential and the pressing need to understand the environment. The significance of environmental education was acknowledged globally when the 'Human Environment' conference, often known as the 'Stockholm Conference,' was held in Stockholm in 1972. This conference, which was attended by delegates from 113 countries as well as governmental and UN agencies, emphasized the critical role that environmental education plays in tackling major environmental issues that face the world today.

The conference promoted the creation of the United Nations Environment Programme (UNEP), the launch of a "environment fund," and the designation of June 5th as "World Environment Day" as part of its strategic goal. In order to turn these suggestions into actionable plans, concerted efforts were made to establish a worldwide program in environmental studies. An interdisciplinary approach was taken by this curriculum, both inside and outside of official educational settings. In January 2015, Unison launched the International Environment Education Programme (IEEP) in partnership with the United Nations Environment Programme (UNEP). IEEP's main goals were to create and assess creative approaches, materials, curriculum, and programs specifically designed for Environmental Studies in both official and informal education. As part of these efforts, staff members were trained and retrained to guarantee that environmental education programs were carried out successfully. The historic International Environment Education Workshop in October 2015 in Belgrade, Yugoslavia, marked a turning point in the field as delegates from 63 percent of the nations underlined the importance of Environmental Studies curricula in both formal and informal education. The Environment Orientation of School Education program was launched by the Ministry of Human Resources Development (MHRD) in 2017 and was implemented in all states and union territories. The education department worked in tandem with nonprofit organizations that specialize in environmental studies to accomplish this plan.

The objectives of Environmental Science can be divided into the following categories

Consciousness To assist people and social groups in gaining a deep understanding and consciousness of the world around them and the intricate problems they face.



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Understanding To support individuals and social groups in gathering a variety of experiences and developing a basic comprehension of the environment and related problems.

Principles To imbue social groups and individuals with a moral code and a sense of responsibility towards the environment, thereby fostering an active desire to contribute to its preservation and improvement.

Proficiency To give individuals and social groupings the tools they need to identify environmental issues and take appropriate action.

Engagement To provide a means of active participation at all levels for social groupings and individuals in tackling environmental concerns.

The objectives of Environmental Science play a pivotal role in the effective formulation, execution, and assessment of its programs. However, a comprehensive understanding and achievement of these objectives are contingent upon a thorough comprehension of our environment, including its components. These goals fall into one of three categories that Bloom explains in his work, "Taxonomy of Educational Objectives": cognitive, emotional, and psychomotor.

1. The cognitive domain includes goals pertaining to the acquisition of intellectual skills and talents as well as the retrieval or recognition of knowledge. This domain encompasses a wide range of behaviours, from simple memory recall to complex actions requiring abstract thought and problem-solving, such handling complicated situations.
2. The affective domain encompasses goals that specify modifications in values, interests, and attitudes as well as the development of useful applications and adaptations. It includes a wide range of activities, from routine attention to profound self-awareness and hands-on humanitarian work. It encompasses a range of behaviours, such as intense affinity and attraction to particular items, as well as aversion, hostility, or fear.
3. The psychomotor domain focuses on motor skills and manipulative abilities. This area includes neuromuscular coordination observed in activities such as handwriting, public speaking, physical exercises, dancing, yoga, tool handling, and various tasks essential for socially beneficial productive work, vocational, and technical courses.

Principles of Environmental Education

The foundational principles advocating the integration of Environmental Education into the school curriculum are delineated below

- i. Environmental Education facilitates the structured progression of learning experiences from simplicity to complexity.
- ii. Environmental Education aids in the transition from vague and indefinite ideas to clear and specific concepts.
- iii. Environmental Education guides the journey from tangible and concrete phenomena to abstract and theoretical understanding.
- iv. Environmental Education contributes to the organization of learning encounters, progressing from empirical observations to rational analyses.
- v. An inherent corollary to the aforementioned principle, cherished by educators, asserts that education should facilitate the child's self-development process.
- vi. An essential educational principle pertinent to Environmental Education programs is the sense of enjoyable excitement they evoke in students.
- vii. The core principle of Environmental Education lies in its problem-oriented approach, focusing on understanding the environment and the perils of pollution, encompassing issues such as air and water pollution.
- viii. A vital tenet of Environmental Education is its social relevance, emphasizing its connection to human interaction with the physical and social environment, and its role in shaping evolving human attitudes.

Environmental Education (EE) reflects the diversity of environments that exist in different parts of the world. Efforts have been undertaken in the disciplinary, multidisciplinary, and transdisciplinary domains to advance EE through legislation, community involvement, and formal or informal educational institutions. All educational levels, from elementary and secondary to postsecondary, should incorporate environmental education, using both formal and



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informal teaching methods. A wide range of people are served by environmental education, including the general public, homemakers, administrators, engineers, medical professionals, and students. In order to improve the quality of Environmental Education (EE) in formal educational institutions, a particular emphasis on teacher education is required, utilizing both formal and informal educational techniques.

National Curriculum Framework for School Education

The 2015 National Curriculum Framework underscores a pedagogical approach centered on the learners' surroundings, integrating environmental awareness from the early stages of education. Classes I and II are dedicated to weaving teaching and learning experiences around the immediate environment, with distinct Environmental Studies introduced from classes III to V. Environmental Science becomes an integral component of the science and social sciences curriculum during the Upper Primary Stage, spanning three years. The primary emphasis during the initial years remains on tangible elements such as objects, events, and natural phenomena within the learners' immediate surroundings. Throughout primary education, students are encouraged to observe, explore, and identify occurrences within their immediate environment. At the upper primary stage, learning continues to heavily draw from the environment, fostering a deep understanding of ongoing changes. In secondary education, the study of science remains rooted in the natural and social elements of the environment.

Despite the outlined framework, the integration of Environmental Science in universities and colleges lacks proactive initiatives. To bridge this gap, the University Grants Commission (UGC) mandated all Indian universities to include a compulsory six-month module on environmental studies in undergraduate courses across disciplines, starting from the academic year 2003-04.

Environmental Education in the Indian Education System

Indian universities assume a pivotal role in enriching public consciousness, preserving the environment, and advancing sustainable development through instructional, investigative, and outreach endeavors. In the realm of education, universities can enhance environmental awareness by integrating specialized courses and research papers dedicated to the environment at the Master's level across disciplines. They can craft certification and diploma programs encompassing diverse environmental facets and create concise courses focused on environmental management and resource conservation, specifically tailored for managerial professionals. In the sphere of research, universities can conduct thorough surveys at M.Phil. and Ph.D. tiers, accumulating comprehensive data relevant to sustainable development. Additionally, they can offer consultancy services concerning pollution control. Engaging in outreach initiatives, universities can initiate endeavors aiming to heighten public consciousness regarding the environment. Furthermore, they can actively involve students in eco-development projects like afforestation and water conservation, facilitated through organizations such as NSS. The growing demand for skilled personnel has become increasingly apparent. The significance of teacher training in Environmental Education (EE) garnered international acknowledgment during the inaugural Inter-Governmental Conference on EE convened by UNESCO in 1977 in Tbilisi, USSR. The Tbilisi Conference Report outlined indispensable recommendations for educating personnel in EE

- Environmental Science should be seamlessly integrated into pre-service teacher education curricula.
- Faculty members in teacher education institutions should undergo thorough training in these domains, emphasizing practical training and collaboration with professional teacher organizations.
- Proficiency in environment-related subjects should be cultivated among teachers, learners, administrators, and educational planners.
- Teacher training programs in environmental education should concentrate on developing knowledge, skills, and attitudes concerning the environment, its challenges, and predicaments. These programs should also enhance capabilities in instructing and overseeing activities associated with EE.

It is imperative to recognize the fundamental role teachers play in the effective execution of Environmental Science education. Specialized training for both teachers and teacher educators is indispensable, enabling them to adeptly



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integrate environmental perspectives into their educational frameworks. This approach aligns with global ethical principles, emphasizing the enlightenment and training of educational practitioners. Consequently, there exists an urgent need for robust teacher education programs meticulously tailored for educators and teacher educators. Acknowledging this imperative, UGC and NCERT have launched diverse initiatives aimed at augmenting university and school curricula within the realm of Environmental Science. Notably, UGC initiated a groundbreaking Environmental Science project in April 1994, designating the Faculty In recognition of this need, UGC and NCERT have initiated a number of programs targeted at enhancing university and school environmental science curricula. Notably, in April 1994, UGC launched a novel project in environmental science, naming the Mahatma Gandhi Kashi Vidyapeeth, Varanasi, Faculty of Education as the regional centre for environmental science teacher training. These comprehensive teacher preparation programs in environmental science are being systematically implemented at all levels in order to fulfill the growing demand for qualified teachers. Of Education at Mahatma Gandhi Kashi Vidyapeeth, Varanasi, as a regional hub for teacher training in Environmental Science. These all-encompassing teacher training endeavours in Environmental Science are being systematically executed across multiple levels to meet the escalating demand for adept educators.

CONCLUSION

Teachers occupy a pivotal position in shaping the behavior, etiquette, and moral integrity of children. Therefore, for the successful execution of environmental awareness initiatives, it is imperative that teachers possess a profound understanding of Environmental Science. To guarantee this, the duty falls upon teachers' training institutions and universities to equip educators for this crucial task. The current teacher training syllabus must be restructured to include Environmental Science material, highlighting efficient methods for conveying this information in educational institutions. Furthermore, there must be an emphasis on cultivating abilities to orchestrate Environmental Science initiatives harmonized with extracurricular undertakings.

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A Study on Medical Image Denoising by using Filtering and Transform Methods

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ABSTRACT

Accurate disease diagnosis is crucial in today's era. since once it is done correctly, effective treatment in the right direction follows. Therefore, medical images should be noiseless for effective diagnosis, hence the concept of a Medical image Denoising has a big part to play. Different sorts of noises, such as speckle noise, Gaussian noise, salt and pepper noise, etc., were also present while recording X-rays, CT scans, MRI images, etc. So by using different types of techniques we need to reduce the noise to a certain extent or removal of noises is essential. In this paper, we are going to compare different types of denoising techniques by using traditional spatial filter methods and transform methods and finally the quality of the denoised images are measured for analysis.

Keywords: Spatial domain, transform domain, image denoising, Medical images

INTRODUCTION

Computed tomography (CT) is an important radiological diagnostic tool used in medical imaging to examine the internal anatomy of human organs. When compared to traditional X-ray methods, CT is a complete method that incorporates a mathematical theory of object reconstruction from projections obtained from multi-angular X-rays.[1], [2]. Basically image noise is due to additive or multiplicative. Original image could be corrupted by adding noise signal .





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$$f(x, y) = s(x, y) + t(x, y)$$

Here, $s(x, y)$ represents the original image intensity and $t(x, y)$ represents the noise supplied to produce the corrupted signal $f(x, y)$ at (x, y) element position. Environmental factors, low light, dust particles etc. are some of the sources for noise.

Different Types of Noise

Some of the different types of noises are Gaussian noise, salt and pepper noise, Poisson Noise, Speckle noise.

Gaussian Noise

The Gaussian noise is a noise induced by electronic amplifiers or detectors. It follows a Gaussian distribution. In medical images, this noise is uniformly distributed for the whole signal. Therefore by affecting the greyscale images actual view. The graph is bell shaped.

Salt and Pepper Noise

The impulsive and spike noise is another name for the salt and pepper noise. At random intervals Black and white pixels appear. This type of noise is caused by sudden changes in the image signal and issues with the image-capture hardware. Salt and pepper noise may be present in images with sparsely black and white pixel occurrence. Dark pixels will appear in bright areas of the image with salt-and-pepper noise, and vice versa. An efficient noise reduction method for this kind of noise is to use various types of filters. Sometimes due to improper switching electric interferences, salt and pepper noise occurs into images.

Poisson Noise

Usually X rays are produced using photons. The images formed in X rays are bound to follow a statistical distribution. Here photons, film holder, receptor and patient follow a Poisson process and due to that quality of image is degraded with noise called Poisson noise.

Speckle Noise

Speckle noise is one type of multiplicative noise. They can be observed in coherent imaging systems like laser, radar, and acoustics, among others. Similar to Gaussian noise, speckle noise can also exist in an image. Its probability density function follows gamma distribution [4]. Speckle noise can be seen in edges. If image quality is poor and images have a backscattered wave appearance from numerous microscopic reflections that pass through internal organs, diagnosis will be very challenging. Because of this, it is more challenging for the examiner to distinguish minute details in the images. [5]

Denoising methods

The noise reduction methods classified based on denoising approaches are (i) filtering method, (ii) transform domain method, (iii) statistical method and (iv) methods in Machine Learning. In filtering method, the linear or non-linear filters are used to eliminate the noise. Transform domain method specifies Fourier Transform (FT), Wavelet transform (WT), Curvelet transform (CT) etc. to suppress noise from images. Maximum likelihood approach, linear minimum mean square error (LMMSE) estimation etc. are the statistical methods used to estimate noise from the given image in X ray. [6] Traditional method for removing noise is spatial filter method. When there is only additive noise present, spatial filtering is the preferred technique. It can be divided into two additional categories: Linear filters and Non Linear Filters

Linear Filters

This method is applicable when only additive noise is present.

Non Linear Filters

This method is applicable when multiplicative and function based noise is present. This image denoising technique is primarily used and concentrated in the field of medical applications, and it plays a significant role in a wide range of



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applications such as image registration, image classification, and image segmentation, in which we obtain the distinctive image content, which is necessary for improved performance and diagnosis. The goal of this image noise reduction problem is to remove the noise from an image and restore it to its original state of cleanliness and clarity. The image used here serves as the input and is made up of the sum of relevant pixels from the noisy (unclean) image that correspond to the pixels in the clean image (noise-free). [7][8]

Different types of transform domain for denoising

The Fourier transform is an effective tool for analyzing a stationary signal's constituent parts (a stationary signal is a signal where there is no change in the properties of signal). Fourier transforms, which are made up of a variety of sine and cosine signals (sinusoids), are one of the powerful tools. In order to analyze non-stationary signals, the Fourier transform is not particularly helpful. However, wavelet transforms are helpful in non-stationary signal component analysis. Additionally, wavelets enable the creation of filters for both stationary and non-stationary signals [11]. In the frequency domain, Fourier transforms primarily operate. Wavelets transform has an advantage over Fourier transform in both time and frequency in a mathematical approach.[9] Discrete Wavelet Transforms reduces structural distortions between the various images, it is essential for image fusion[10].The disadvantages of the discrete wavelet transform include its lack of shift invariance, poor directional selectivity, and lack of phase information. Stationary Wavelet Transform and Dual Tree Complex Wavelet Transform are used to get around these drawbacks. [1][11] The size of the application area corresponds to the size of the wavelet theory .Initially Applications for wavelets is included in signal processing and filtering. However, wavelets have been used extensively in areas like non-linear regression and compression. A time series' degree of determinism can be estimated[12]. The primary distinction is that while the standard Fourier transform is only well localized in the frequency domain, wavelets are well localized in both the time and frequency.

Using multi resolution analysis, wavelets frequently provide a better signal representation, but there is a problem with frequency time resolution because in short time Fourier transform as it is localized. [13] A single function is the foundation of the Fourier transform. This function $t(\psi)$ is scaled, However, the wavelet transform function can be shifted, which leads to the generation of a two parameter family of functions. [14][15] Contrary to narrow band interference, linear filtering is not suitable for the suppression of broadband noise because it significantly crops the edges of the pixels in the image. The noise spectrum dominates and significantly overlaps with the picture spectrum at higher frequencies. As a result, automatic interpretation is difficult even after precise visual characteristic recognition. When compared to linear filtering, the discrete wavelet transform can increase the efficiency of visual noise suppression. The signal is split into bands by WT, with the higher bands containing noise and some additive image components and the lower bands containing more image components. Depending on the anticipated magnitude of the interference, the transform coefficients can be modified in order to filter the signal. [16] Dyadic SWT is used to estimate a noise-free signal in addition to being used in the wiener filter. identifying the ideal filter bank and advising additional wiener filter parameters The appropriate values for the parameters were selected in order to improve the average resulting signal-to-noise ratio. noise ratio (SNR) for each of the tested signals. We verified that the noise level or SNR affects the appropriate values of these parameters.

Automated estimation of the SNR was added to a general filtering scheme that already included the filter itself as well as the estimation of a noise-free signal. 1. STATIONARY WAVELET TRANSFORM (SWT) The WT provides information about the signal's time characteristics in addition to its frequency characteristics. So, Wavelet transforms has been used as an effective tool for signal processing. [17] [18]The benefits of wavelet transform are as follows: i. The entire frequency domain can be covered by wavelet decomposition (providing a mathematically complete description) ii. By choosing the right filters, wavelet transform can significantly reduce or eliminate the correlation between the extracted various features. The wavelet transform has a "zoom" feature, high-frequency resolution, low time resolution, and is accessible in low frequency band, iv. There is a quick algorithm for the wavelet transform's implementation (the Mallat wavelet decomposition). To get around this, wavelet transforms like the ridgelet and randon transform are used. Since curvilinear wavelet transforms have poor directionality, they are divided into horizontal, vertical, and diagonal wavelet transforms. Additionally, because shift variance is not provided, edges are





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not preserved properly. Curvelet and ridgelet transforms are used to address this. The random transform, which ridgelet transforms use, only provides information on the orientation of linear edges. There were still discontinuities. Later, the terms Ripplet and contourlet are defined to address and overcome discontinuities along smooth curves. Once more, these transforms are not useful in resolving the issues. In order to address the limitations of traditional two-dimensional discrete wavelet transforms, a multi resolution geometric analysis (MGA), curvelet transform, was developed. The curvelet transform enables a nearly ideal sparse representation of objects with C^2 singularities in the two-dimensional (2D) case. [19] The primary drawback of curvelets is that they are not built in a discrete domain and do not offer multi-resolution geometry representation. Shearlets are then discussed because they provide an effective multidirectional and multi scale framework for anisotropic features. Shearing and parabolic scaling are applied to specific generating functions in this instance of shearlets translation. In order to produce waveforms with anisotropic support, the scaling operator is necessary. We make use of the family of dilation operators (DA_a , $a > 0$), based on a 2×2 matrix of parabolic scaling matrices ($A_a = \begin{pmatrix} a & 0 \\ 0 & \sqrt{a} \end{pmatrix}$), where the dilation operator is presented as wavelets. The wave forms orientations are altered by an orthogonal transformation. [20][21] By choosing shearing operator D_s , s belongs to \mathbb{R} and shearing matrix S_s is given by ($S_s = \begin{pmatrix} 1 & s \\ 0 & 1 \end{pmatrix}$). This shearing matrix parametrizes the orientation using the variable s uses slopes instead of angles. Combining three operator including translation operator T_t . We can define continuous Shearlet Transform.[21]

Image Quality check Parameters

After denoising the image the quality of the image is to be checked. For this various measures like MSE, RMSE, SSIM, PSNR are used.

- i) Mean square error (MSE) - Mean Squared Error (MSE) is the square of differences in the pixel values between the corresponding pixels of the original image and denoised image.
- ii) PSNR (peak signal to noise ratio) is the proportion between a signal's maximal power and the power of corrupting noise.

Experimental Results

From kaggle database set of images x ray images of normal and covid patients are taken and after adding different types of noise like salt and pepper, Gaussian, Speckle noise it is denoised using different types of filters and then wavelet transform. After that the quality is checked by calculating MSE and PSNR. The following figures represent the original, noisy and denoised image. Table 1 gives the result of MSE, PSNR of denoised image after using Median filter, Averaging filter, Gaussian filter, Wiener Filter, Discrete Wavelet transform.

CONCLUSION

After applying additive noises and multiplicative noise in the X-ray image various techniques are used to denoise and found that non linear filters work better in speckle noise and wavelet transforms working more better but still have a few flaws. Hence by combining different techniques a proposed hybrid model of shearlet and curvelet transforms can be used. A higher PSNR good quality will result in a better denoised image.

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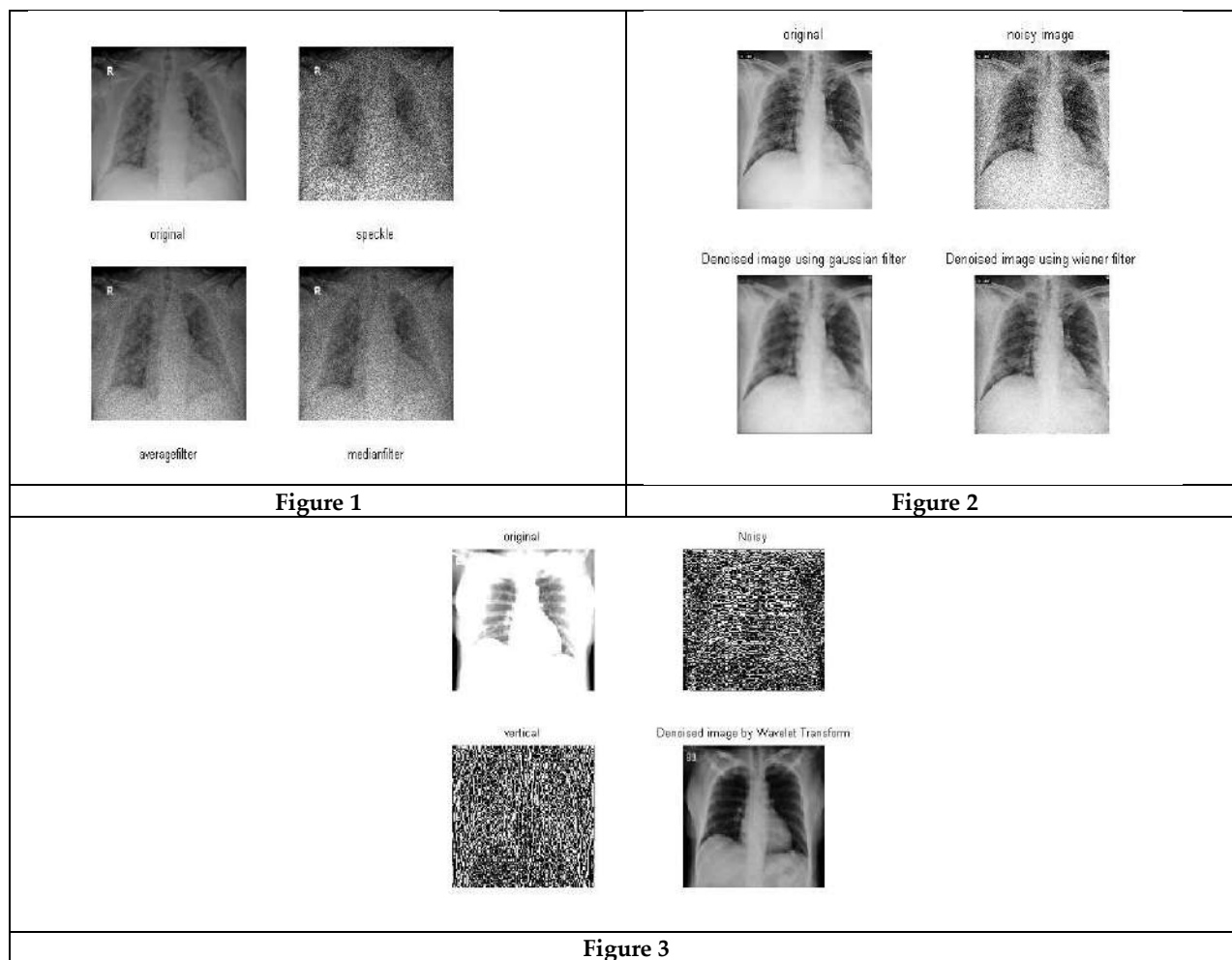
Table 1 Experimental Results

	MSE	PSNR
Median filter	15.7	42.80
Average filter	24.36	25.70
Weiner Filter	17.86	24.35
Gaussian Filter	23.3	28.66
Wavelet transform	14.6	44.29





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Effect of Bedding Systems on Comfort of Crossbred Dairy Cows

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ABSTRACT

Dairying is an important vocation for farmers to access to more nutritious nourishment and to expand their income and for their families. In dairy farming, bedding and its management contribute predominantly to the comfort of cows. Dairy cows prioritise resting over other behaviours and those who are denied the opportunity to lie down exhibit behavioural and physiological abnormalities (Munksgaard and Thomsen, 2012). As the behavior of cows has a direct relation with the comfort and quality of milk, the present study was undertaken to evaluate the different behavior expressed in bedding systems of crossbred cows. The study was carried out on twenty four crossbred cows at the Cattle farm of the Instructional Livestock Farm Complex, Pookode, Wayanad District in Kerala state for one lactation period in three seasons. The effect of different bedding materials such as, rubber mats, coir pith and dried solid manure (DSM) was compared with concrete floor on the behavior of crossbred dairy cows. The cow comfort index 2 h after feeding concentrates, the CCI was highest in coir pith (87.5 per cent) followed by DSM (58.3 per cent). Cows on concrete floor (33.3 per cent) showed lowest cow comfort values followed by cows on rubber mats (50 per cent) during summer. In the monsoon, cows on concrete floor (33.3 per cent) showed lowest cow comfort values followed by cows on rubber mats (50 per cent). In stall standing index, 2 h after feeding concentrates, the cows reared on concrete floor (66.7 per cent) showed highest SSI values followed by cows on rubber mats (50 per cent) whereas, the SSI was least in cows maintained on coir pith (12.5 per cent) followed by the cows on DSM (41.7 per cent) during





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summer. Coirpith and DSM as bedding material could be recommended for use by dairy farmers when compared to rubber mats and concrete floor bedding for improving cow comfort and milk production.

Keywords: Crossbred cows, bedding systems, cow comfort index, stall standing index, milk yield

INTRODUCTION

Cow comfort is important to milk production, milk quality, reproductive efficiency and health of dairy cows. Comfortable stalls result in longer resting times and a reduction of standing time on hard surface. This reduction in standing time may potentially reduce herd lameness incidence. Cow comfort minimizes the stress in animal and environment in order to maximize productive capability. As per the 20th livestock census (2019), India has 192.49 million cattle, ranking second in the world population, while 93 percent of the cattle population are crossbreds in Kerala. The World Organisation for Animal Health (OIE, 2008) has propounded five freedoms in relation to welfare, among them one is freedom from physical and thermal discomfort by providing access to shelter and a comfortable resting area. Another one is freedom to express normal behavioural patterns, by providing sufficient space, proper facilities and company of other animals of its kind. Dairy cows priorities resting over other behaviours and those who are denied the opportunity to lie down exhibit behavioural and physiological abnormalities (Munksgaard and Thomsen, 2012). Various bedding materials are available for the animals such as sand, wood chips, rubber mats, concrete floor, sawdust, straw etc. Choosing a good bedding material is always advisable to improve the welfare, comfort and performance of dairy animals in different seasons. New approaches are being followed to improve the comfort of dairy animals by providing them with appropriate bedding materials. Hence, the present study was undertaken to evaluate the effect of different bedding materials such as rubber mats, coir pith and DSM compared to concrete flooring, on the behavior of crossbred dairy cows.

MATERIALS AND METHODS

The study was carried out at the Cattle farm of the Instructional Livestock Farm Complex, Pookode, Wayanad District in Kerala state during 2018 to 2019. The study was carried out for one lactation period spread over three different seasons as described by Biya (2011) viz., summer months (Feb-May), monsoon months (June-Sep) and post monsoon months (Oct-Jan). Twenty four crossbred dairy cows in early stage of lactation aged between 4 and 6 years were selected for the study. The animals were divided into four groups with six animals in each group as uniformly as possible with regard to their body weight (295 to 350 kg), parity and milk yield (8.10 to 11.30 kg). The animals were let loose in the shed except during the feeding and milking time. Floor space of 13 sq. m and manger space of 1.2 m length and 0.6 m width were provided per cow. Six experimental animals were maintained in the existing management system, viz., concrete floor without any bedding materials (T₁). This group was considered as the control group. Rubber mats on concrete floor of 1.2m × 1.8m × 0.025m were used for six experimental animals (T₂). All other activities including feeding regime were followed as per routine practice. The Rubber mat used in experiment weighed 40 kg. Coir pith was provided at the rate of 7.5 cm thickness as bedding (T₃). DSM was provided at the rate of 7.5 cm thickness as bedding (T₄).

COW COMFORT INDICES

Cow comfort index (CCI)

The CCI was calculated two hours after feeding concentrate and roughage at weekly interval (Nelson, 1996). CCI or cow comfort quotient, defined here are the proportion of cows that are lying down. CCI was calculated as the number of cows lying down divided by the total number of cows in a stall, either standing or lying. If all cows are standing the CCI is zero per cent and if all cows are lying down the CCI is 100 per cent. The most appropriate time to measure indices of cow comfort was two hours before and after the morning and afternoon milking. A single 24 h



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period of activity was captured, during which there were no interruptions for breeding, injections or other management tasks. Lights over the pen were left on during the night so that filming could continue for the full 24 h. Although not ideal, a short period of all day lighting has been used in other studies to facilitate recording without apparent major effects on cow behaviour (Cook *et al.*, 2004). Therefore, to facilitate across-herd comparison for each database, the starting time of the morning milking, when the cows started to milk (h 0) was used as a reference point to align the hourly data for each cow for 2 h after feeding concentrate.

$$\text{Cow Comfort Index (CCI)} = \frac{\text{Number of cows lying in stall}}{\text{Number of cows lying and standing in a stall}} \times 100$$

Stall Standing Index (SSI)

The SSI was calculated after 2 h of feeding concentrate and roughage at weekly interval (Cook *et al.*, 2005). (Where $SSI = 1 - CCI$), which measured the proportion of cows in the stall that were standing with all 4 feet on the stall platform or perching with the front 2 feet in the stall and the rear 2 feet in the alley. SSI was the proportion of cows in the stall that were standing which should be <20 per cent and above that could be associated with abnormally long herd- mean standing indexes and increased levels of lameness. The best time to measure the SSI was approximately 2 h before milking. The SSI was analysed by Kruskal Walli's ANOVA followed by Mann Whitney U test for pair wise comparison between treatment groups. The indices were estimated four times in a day at 7.00 AM (2 h after feeding concentrate), 12.00 PM (2 h after feeding roughage), 4.00 PM (2 h after feeding concentrate) and 6.00 PM (2 h after feeding roughage).

RESULTS AND DISCUSSION

Effect of bedding materials on cow comfort index (CCI)

The CCI of different bedding systems during the three seasons are as follows.

Cow comfort index in summer season

The CCI of animals maintained on different bedding systems in summer season is depicted in Fig. 1. At 7.00 AM, 2 h after feeding concentrates, the CCI was highest in coir pith (87.5 per cent) followed by DSM (58.3 per cent). Cows on concrete floor (33.3 per cent) showed lowest cow comfort values followed by cows on rubber mats (50 per cent). The same pattern of cow comfort was noted 2h after feeding concentrates in the afternoon at 4.00 PM. After 2 h of feeding roughages at 12.00 PM, the CCI was highest in cows maintained on DSM bedding material (83.3 per cent), followed by cows on coir pith bedding (79.2 per cent), rubber mats (41.7 per cent) and concrete floor (33.3 per cent). The same pattern of cow comfort was noted 2 h after feeding roughages in the evening at 6.00 PM. This is in agreement with Overton *et al.* (2003) who reported that cow comfort index of 85 per cent was an ideal comfort level for the cows. Dimonov *et al.* (2015) had reported similar findings who found that the cows maintained on recycled manure solid were found to be more comfortable with CCI of 97 per cent than the cows maintained on coir pith bedding with 88 per cent. The cows maintained on concrete floor had the lowest CCI during all the time periods studied irrespective of the type of feeding followed by the cows maintained on rubber mats. The cows maintained on coir pith showed more comfort once they were fed with concentrate feeding than DMS bedding while on roughage feeding, the cows maintained on DMS were found to be more comfortable than the cows maintained on coir pith bedding.

Cow comfort index in monsoon season

The CCI in different bedding systems during monsoon season is depicted in Fig. 2. At 7.00 AM, 2 h after feeding concentrates, the CCI was higher in coirpith (100 per cent) followed by DSM (83.3 per cent). Cows on concrete floor (33.3 per cent) showed lowest cow comfort values followed by cows on rubber mats (50 per cent). The same pattern of cow comfort was noted 2 h after feeding concentrates in the evening at 4.00 PM. After two hours of feeding



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roughages at 12.00 PM, the CCI was higher (83.3 per cent) each in cows maintained on both coir pith and DSM bedding systems compared to concrete floor and rubber mats (33.3 per cent) each. The same pattern of cow comfort was noted 2 h after feeding roughages whereas in the evening at 6.00 PM, the cows maintained on coir pith and DSM had the highest comfort (100 per cent) followed by the cows on rubber mat (66.7 per cent) and on concrete floor (16.7 per cent). The cows maintained on coir pith had the highest comfort (100 per cent) after they were fed with concentrate, while on roughage feeding, the cows maintained on DSM were found to be equally comfortable (83.3 and 100 per cent) at 12.00 PM and 6.00 PM, respectively. Cook *et al.* (2005) found that the herd mean 24 h stall standing time was linked to CCI and the strongest relationships occurred 2 h before the morning and afternoon milking, in accordance to this study. The cows maintained on coir pith had the highest comfort (100 per cent) after they were fed with concentrate, while on roughage feeding, the cows maintained on DSM were found to be equally comfortable (83.3 and 100 per cent) at 12.00 PM and 6.00 PM, respectively. Sinha *et al.* (2017a) obtained similar results. They found that CCI was lower in concrete flooring than in sand bedding group.

Cow comfort index in post monsoon season

The CCI in different bedding systems in post monsoon season is depicted in Fig. 3. The CCI was highest in the cows maintained on coir pith (100 per cent) at 7.00 AM, 2 h after feeding concentrates followed by the cows on DSM (83.3 per cent). Cows on concrete floor (50.0 per cent) showed lowest cow comfort values followed by cows on rubber mats (33.3 per cent). After 2 h of feeding concentrates in the evening at 4.00 PM, the comfort levels were equal in the cows reared on coir pith and DSM bedding (100 per cent each) followed by the cows maintained on rubber mats (66.7 per cent) and concrete floor (16.7 per cent). After 2 h of feeding roughage the CCI was highest (100 per cent each) at 12.00 PM in those cows maintained on both coir pith and DSM bedding material and lowest (33.3 per cent each) in cows reared on both concrete floor and rubber mats, respectively. After 2 h of feeding roughage in the evening at 6.00 PM, equal levels of comfort were found in the cows reared on coir pith and DSM bedding (100 per cent each) followed by the cows maintained on rubber mats (66.7 per cent) and concrete floor (16.7 per cent). Dimonov *et al.* (2015) measured these indices and found highest values (100 per cent), when the bedding was straw mixed with composted manure, instead of a rubber mat. In post monsoon season, cows maintained on coir pith had the highest comfort, when they were fed on either concentrates or roughages. The cows maintained on DSM were found to be equally comfortable as the cows maintained on coir pith bedding after most feeding time. In post monsoon season, Ito *et al.* (2009) had stated that the CCI and SSI have no correlation with the amount of daily lying time and season which was contradictory to the present findings.

Effect of bedding materials on stall standing index (SSI)

The SSI in different bedding systems during the three seasons are given as follows.

Stall standing index in summer season

The SSI of cows maintained on different bedding systems in summer season is depicted in Fig. 4. At 7.00 AM, 2 h after feeding concentrates, the cows reared on concrete floor (66.7 per cent) showed highest SSI values followed by cows on rubber mats (50 per cent) whereas, the SSI was least in cows maintained on coir pith (12.5 per cent) followed by the cows on DSM (41.7 per cent). The same pattern of SSI was noted in the cows reared on different bedding systems 2 h after feeding concentrates in the evening at 4.00 PM. After 2 h of feeding roughages at 12.00 PM, the SSI was highest (66.7 per cent) each in cows maintained on concrete floor and rubber mat bedding system followed by the cows on coir pith (29.2 per cent) and DSM (16.7 per cent). After 2 h of feeding roughages, the SSI was in decreasing order for cows maintained on concrete, rubber mat, coir pith and DSM (58.3, 33.3, 12.5 and 0 per cent), respectively in the evening at 6.00 PM. The findings are similar to Cook *et al.* (2004) as they reported CCI >85 per cent for the cow which returned 1 h after morning milking on sand or rubber crumb mattress surface in free stalls. During summer season, cows maintained on concrete floor had the least comfort index followed by cows on rubber mats after feeding. Whereas, the cows maintained on coir pith and DSM were found to be equally comfortable 2 h after the feeding time which might be due to the comfort and insulation provided by the bedding systems.



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The SSI of cows maintained on different bedding systems in monsoon season is depicted in Fig. 5. At 7.00 AM, 2 h after feeding concentrates, the cows reared on concrete floor (66.7 per cent) experienced highest SSI values followed by cows on rubber mats (50 per cent) whereas, the SSI was least in cows maintained on coir pith (12.5 per cent) followed by the cows on DSM (41.7 per cent). The same pattern of SSI was noted in the cows reared on different bedding systems 2 h after feeding concentrates in the evening at 4.00 PM. After 2 h of feeding roughages at 12.00 PM, the SSI was highest (66.7 per cent) each in cows maintained on both concrete floor and rubber mat bedding system followed by the cows on coir pith and DSM bedding (16.7 per cent each). The SSI was in decreasing order for cows maintained on concrete, rubber mat, coir pith and DSM (83.3, 33.3, 0 and 0 per cent), respectively after 2 h of feeding roughages, in the evening at 6.00 PM. In contrast, Gastelen *et al.* (2011) differed from the present study who found no differences in both indices of CCI and SSI in box compost, sand, horse manure and foam mattresses, irrespective of seasons. During monsoon season, the cows maintained on coir pith and DMS were found to be equally comfortable 2 h after the eating time whereas, the cows maintained on concrete floor had the least comfort index followed by cows on rubber mats after eating concentrate and roughage.

Stall standing index in post monsoon season

The SSI of cows maintained on different bedding systems during post monsoon season is depicted in Fig. 6. The cows reared on concrete floor (66.7 per cent) showed highest SSI values, followed by cows on rubber mats (50 per cent) whereas, the SSI was least in cows maintained on coir pith (0 per cent) followed by the cows on DSM (46.7 per cent) at 7.00 AM, 2 h after feeding concentrates. The same pattern of SSI was noted in the cows reared on different bedding systems 2 h after feeding concentrates in the evening at 4.00 PM with highest SSI value in cows reared on concrete floor (83.3 per cent). After 2 h of feeding roughages at 12.00 PM, the SSI was highest (66.7 per cent) each in cows maintained on both concrete floor and rubber mat bedding system followed by the cows on coir pith and DSM bedding (16.7 per cent each). In the evening at 6.00 PM, SSI values were in decreasing order for cows maintained on concrete, rubber mat, coir pith and DSM (83.3, 33.3, 0 and 0 per cent), respectively after 2 h of feeding roughages. During the post monsoon season, the cows maintained on coir pith and DMS were found to be equally comfortable 2 h after the feeding time whereas, the cows maintained on concrete floor had the least comfort index followed by cows on rubber mats after feeding concentrate and roughage. Similarly, Haley *et al.* (1999) also reported that the SSI was more in dairy cows individually housed in tie-up stalls on a concrete floor, than on a mattress flooring which stood longer 2.1 h/d. Also, the cows were more reluctant to change position during post monsoon from lying to standing which is in agreement with the present study.

Milk yield

The mean daily milk yield of cows in different bedding materials is presented in Table 1. The results revealed that the type of bedding material, season and the interaction between seasons and bedding materials significantly alter the mean milk yield of cows ($P < 0.05$). The cows maintained on concrete floor had the lowest overall daily milk yield (8.66 ± 0.22 kg) while the cows on coir pith had the highest yield (9.98 ± 0.30 kg). Reneau *et al.*, 2005 reported that milk production increased to 9.57 ± 0.12 kg in compost bedded pack than bedded with dry fine wood shavings or sawdust (9.76 ± 0.03 kg) (). The rubber mat and DSM had the overall mean milk yield of 9.26 ± 0.20 kg and 9.48 ± 0.22 kg, respectively indicating their superiority over the concrete floor. Greater activity and better overall milk yield were observed in high-yielding dairy cows reared on elastic rubber flooring (9.28 ± 0.12) than that on concrete flooring (8.68 ± 0.12 kg) in a loose housing system (Kremer *et al.*, 2007). The per cent increase in milk yield was 19.50, 17.21, 15.33 and 12.14 on coir pith, DSM, rubber mat and concrete floor, respectively. The mean milk yield of 11.34, 10.32, 9.31 and 9.26 L/animal/d in coir pith bedding at a thickness of 30 cm, 20 cm, 10 cm on concrete floor and in the present study bedding material of 7.5 cm thickness was provided (Singla *et al.*, 2007). From Table 1, it may also be inferred that the mean milk yield of cows maintained on different bedding materials were also influenced by the seasonal variations as the differences of overall means of milk yield during different seasons within the cow groups were statistically significant ($P < 0.05$). Moreover, the mean values for different seasons ranged from 8.15 ± 0.09 kg in summer to 10.66 ± 0.09 kg in monsoon. Singh *et al.* (2015) obtained the highest seasonal milk production of $10.52 \pm$



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0.12 and 9.54 ± 0.14 kg in crossbred during winter and summer season, respectively with significant difference ($P < 0.05$) in seasonal variation and milk production performance which is similar with the present study.

CONCLUSION

The behaviour of crossbred cows in different bedding systems was assessed in the present study. The cows maintained on concrete floor had significantly ($P < 0.01$) shortest overall mean lying time (09.23 ± 0.04 h) per day while the cows on coir pith had the longest lying time per day (11.15 ± 0.05 h). The overall mean duration of lying bouts in the cows maintained on concrete floor (1.11 ± 0.04 h) was significantly ($P < 0.01$) shortest while the cows on coir pith had the longest overall duration of lying bouts (1.80 ± 0.12 h). The cows spent overall eating time of 4.31 ± 0.03 and 4.35 ± 0.02 h on rubber mat and DSM, respectively with significant difference ($P < 0.01$) between them. The cows maintained on concrete floor had the lowest overall daily milk yield (8.66 ± 0.22) while the cows on coir pith had the highest milkyield (9.98 ± 0.30 kg). Thus, coir pith and DSM as bedding materials could be recommended to the dairy farmers compared to rubber mats and concrete floor bedding for reducing microbial count and improving and milk production.

ACKNOWLEDGMENT

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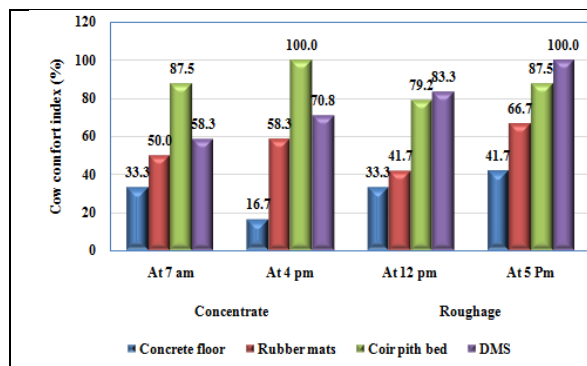
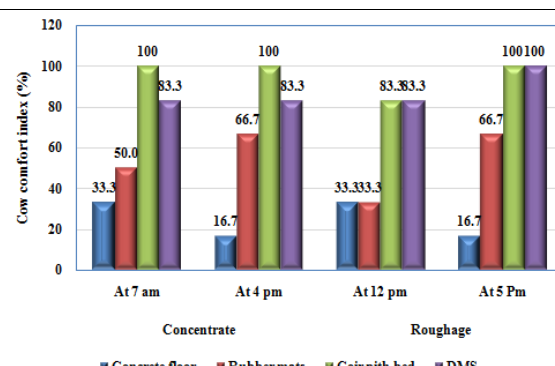
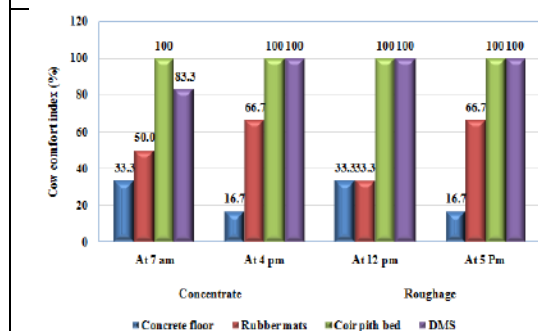
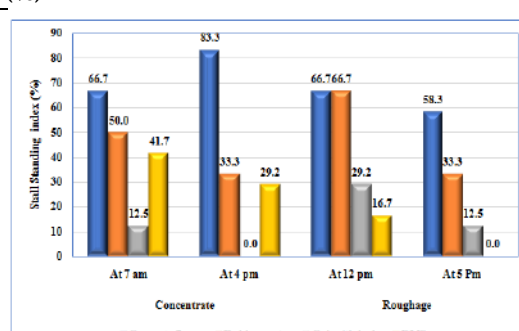
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Table 1. Mean daily milk yield in different bedding systems during different seasons

Treatments (n=6)		Daily milk yield (Mean± SE) (kg)			
		Summer	Monsoon	Post monsoon	Overall
T ₁	Concrete	8.16 ± 0.07	9.31 ± 0.03	9.28 ± 0.03	8.66 ± 0.22 ^d
T ₂	Rubber mat	8.23 ± 0.01	10.28 ± 0.03	9.30 ± 0.03	9.26 ± 0.20 ^c
T ₃	Coir pith	8.35 ± 0.04	11.28 ± 0.04	10.35 ± 0.03	9.98 ± 0.30 ^a
T ₄	DSM	8.28 ± 0.01	10.75 ± 0.03	9.41 ± 0.05	9.48 ± 0.22 ^b
(Mean± SE)		8.15 ± 0.09 ^C	10.66 ± 0.09 ^A	9.52 ± 0.15 ^B	9.34 ± 0.13

Means with different superscripts (a-d in rows, A-C in columns) differ significantly ($P < 0.05$)**Fig 1. CCI indifferent treatments at summer season (%)****Fig 2. CCI in different treatments at monsoon season (%)****Fig 3. CCI in different treatments at post monsoon season (%)****Fig 4. SSI in different treatments at summer season (%)**



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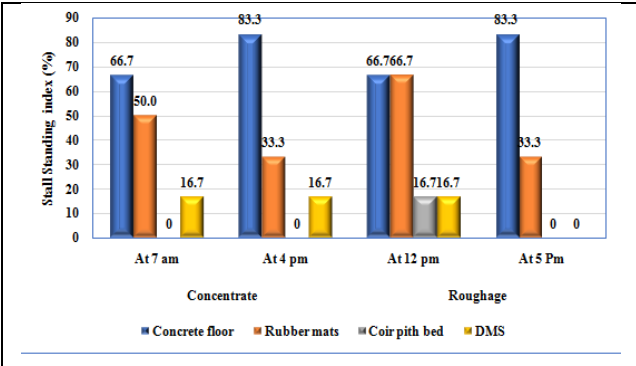


Fig 5. SSI in different treatments at monsoon season (%)

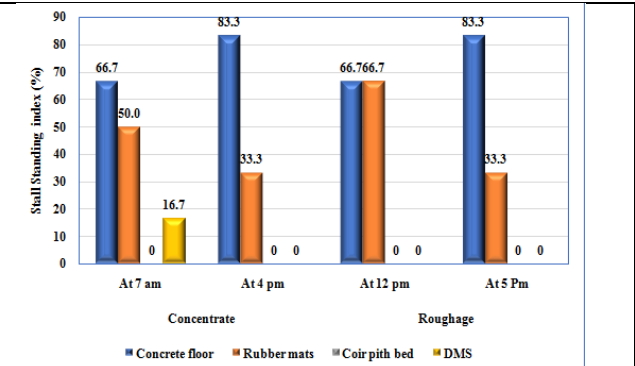


Fig 6. SSI in different treatments at post monsoon season (%)





A Systemic Review of Articles on *Sorana shukla* (Corneal Ulcer)

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ABSTRACT

A corneal ulcer, a defect in the corneal epithelium involving deep layers of cornea, is a potentially vision-threatening ocular emergency. Even with proper treatment on time patients may suffer significant morbidity or complications including corneal scarring or perforation, cataracts or anterior and posterior synechiae, development of glaucoma, uveitis and vision loss. Untreated corneal ulcer may result in end ophthalmitis, pan ophthalmitis or subsequent loss of the eye. According to national blindness and visual impairment survey 2015-2019, corneal opacity was responsible for 7.4 % causes of blindness in aged more than 50 years and 37.5% in aged up to 49 years. One recent study claims that the incidence of corneal blindness is 15.4%, corneal ulcer contributing (9.34%) rest being corneal dystrophy (0.49%), keratomalacia (1.68%), corneal opacity (3.67%) and keratoconus (0.009%). Corneal ulcer may be because of bacterial, fungal, viral or parasitic origin. If we discuss about bacterial corneal ulcer only, treatment of bacterial corneal ulcers consists first of topical antibiotics, most commonly with fluoroquinolones such as ciprofloxacin or ofloxacin. Due to growing antibiotic resistance of common ocular pathogens corneal culture and sensitivity testing is recommended for all corneal ulcers, especially those that are large, central, and correlate with significant stromal involvement. Hospitalization with systemic therapy with ceftriaxone as well as topical therapy is necessary for ulcers caused by gonococcus. Adjuvant corticosteroids are controversial but may be beneficial in specific subgroups of patients. Thus, the disease is not only related to the mortality but also putting a lot of burden on patient's pocket due to investigations, long duration in recovery and high cost of modern medicines and is a major problem in India which adds a substantial burden to the community in general. Similarly, it is very difficult to treat fungal, viral as well as parasitic corneal ulcer. In such conditions, there is a wide scope to explore the variety of pertinent medicines which has been described in Ayurvedic classical texts for the use at various stages of corneal ulcer so that progress of disease could be arrested within a short period of time. So, in this article, focus is on the summarization of the various clinical studies, case reports and



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review articles on corneal ulcer according to *Ayurveda*, so that the future researcher can take a step ahead of this for further research on large sample.

Keywords: *Soranashukla*, Corneal Ulcer, *Jalaukavacharna*, *Ghratpan*

INTRODUCTION

Corneal ulcer may be defined as discontinuation in normal epithelial surface of cornea associated with necrosis of surrounding corneal tissue. Pathologically, it is characterized by oedema and cellular infiltration [1]. In other words, Loss of epithelium is termed as epithelial defect but if the loss of epithelium is associated with inflammation in the surrounding cornea, it is called as corneal ulcer. A corneal scar is the final outcome of any corneal inflammation [2]. Corneal ulceration is a vision threatening condition affecting all age groups and in both sex that varies in morbidity worldwide. It might resolve with no medical intervention or may lead to advancement to next stage and leave behind an opacity which if focal and deep may cause prompt loss of vision or blurred vision depending on the location of ulcer (either central or peripheral) and depth of ulcer (either nebula or macula or leucoma). Variety in occurrence of infectious keratitis is a multi-factorial issue that includes a mixture of different causative factors, for example, geological and other area related elements.[3] According to some studies, it is generally acknowledged that bacterial and fungal keratitis which ultimately leads to development of corneal ulcer have far higher rate in the developing world than that in the developed world [4,5].

Also, it is thought that viral keratitis is more prevalent in developed countries, such as the United States where Herpes Simplex Keratitis (HSK) is considered the leading cause of corneal blindness [6,7] However, predominance of bacterial and fungal keratitis in developed countries has been reported. [8,9,10] The disease *Soranashukla* explained in ayurvedic classical texts is analogous to corneal ulcer as explained in modern medical science as most of the aspects like aetiopathogenesis, clinical features and complications of allergic Rhinitis are like that of *Soranashukla*. Ayurveda, the science of longevity suggests that when ulcer is situated away from pupil, not deep rooted, without pain, and not exudating fluids, it can be treated [11]. Based on this we can apply many effective treatments which can provide the optimum cure and prevent further recurrence of the disease by enhancing the body immunity. During the recent few decades, constant efforts have been made to apply the wisdom of Ayurvedic science for the effective management of various diseases and it has come out with beneficial claims as well. Many articles have been published pertaining to the understanding and management of corneal ulcer in Ayurveda. The search and systemic review of such relevant articles accomplishes the better understanding of the topic, their correlation and the study of various research work done till date. The detailed analysis of the previous studies and recent developments on the treatment of *Soranashukla* helps to understand the limitations and suggests the areas of further research that should be explored. Thus, the present article is an attempt to combine as well as integrate and critically analyse the articles published on *Soranashukla* (corneal ulcer) between the year 2008 and 2022 available at various search portals.

Data Sources

The electronic databases; Online Journals in the field available at various search portals, Bibliographies of located articles.

Selection of Articles

The articles that are available in different search portals published in between the year 2008 to 2022 have been selected for the analysis.

Observation on the Correlation

Corneal ulcer is correlated to ulcerative keratitis in 5 articles out of the 8 articles. In 2 articles it is correlated to corneal ulcer and in one article it is considered as corneal ulcer due to trauma.





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Observation on Type of Article:

Out of the 8 articles analysed 2 were case studies, 4 were review article and one article on a pilot study and one is prospective study of corneal ulcer.

Observation on the Sample Size of Clinical Trial

60 pts were selected in pilot study, 60 pts were in prospective study of corneal ulcer and their microbiological profile and others were case studies on single subject.

Observation on Interventions of Clinical Trial

Out of the 4 clinical trials 1 was having *Jalaukavcharna* with *Rajanyadi Ashchyotana* and *Anu Tail Nasya* as an intervention, 1 was on effect of *Triphalaghrit Abhyantara Pana* on the pts. having treatment from the modern medicines, 1 was having *Shodhana* and *Shamana* combined as an intervention and includes *Virechana*, *Jalaukavcharna*, *Seka* therapy, *Tarpan* therapy, *Anjana Karma* and *Shaman Aushadhi*, one was prospective study.

List of Aushadhi in Clinical Trial

Out of 4 clinical trial 1 trial was done with *Jalaukacharna* (on *lalat*, *Apang* and *Upnashika* region), *Rajanyadi Ashchyotana* and *Anu tail Nasya* [12]. One study was done as comparative study with sample size 30 pts having routine modern medicines but willing for having *Ayurvedic* treatment for fast recovery were given *Triphala Ghrit* for *Abhyantar Pan*. [13] One was a case study with the treatment including *Patolmooladi Kashaya*, *Kaishor Guggul*, *Jalaukavcharna*, *Patoladi Ghrit Achchpan*, *Virechan* with *Avipattikar Choorna*, *Nasya* with *Anu Tail*, *Anjan* with *Jatimukkaladi Varti*, *Tarpan* with *Jeevneeya Gana Ghrit*, and use of *Jeevanyadi Putpak*. [14]

DISCUSSION

Sorranashukla is a *Rakta Dosha Pradhan* disease and *Acharya Shushruta* has advocated *Raktamokshana* in *Raktaj Vyadhi*. *Jalaukavacharan* is preferred way of *Raktamokshana* in ophthalmic diseases. Saliva of *Jalauka* (Leech) contains *Bdelins*, *Eglins* which have analgesic & anti-inflammatory properties. *Acetyl choline* of *Jalauka's* saliva stimulates parasympathetic action of oculomotor & facial nerves. *Hyaluronidase* *carboxypeptidase* also cause vasodilatation & enhance blood supply to the affected organ. It increases tissue permeability & facilitates intracellular fluid movements. It depolymerises *hyaluronic acid* and hence increases diffusion & penetration of drug at sites. All these factors contribute to reduce inflammation of *Savranashukla*. Saliva of leech (LS) contains more than 100 bio active substances which is responsible for various therapeutic benefits like anticoagulant, anti-inflammatory, anesthetic, thrombolytic, vasodilator, and anti-edematous, bacteriostatic and blood- and lymph-circulation enhancing properties. This add up to the importance of the removal of erythrocytes components of the blood from the site which is always primary source of *Raktaja Roga*. *Jalauka* contain enzymes that reduce scar tissue and adhesions. *Fibrinases* and *collagenase* in saliva reduces the density of scar tissue and it helps to reduce fibroblast formation in corneal ulcer. This means healing of even deep-seated corneal ulcer doesn't lead to development of corneal opacity or may be very less corneal opacity. Because central corneal opacity caused by healed corneal ulcer is again a threat to the vision. [15] Similarly, in *Triphala Ghrit* both *Triphala* and *ghrit* are having *Chakshushya* property means they are good for eyes. *Ghrit* contains *K2* and *lionic acid*, *vitamin A* etc. and it is also having anti-inflammatory properties. Anti-inflammatory and nourishing property reduces corneal edema and promotes regeneration of new epithelial layers. Thus helps in reducing the duration of healing time of *Savranashukla* [16]

CONCLUSION

Corneal blindness is one of the vision threatening problems in the field of ophthalmology and is a great challenge to the medical profession in general and ophthalmologists in particular. This challenge can be faced boldly by the combined effort of ayurvedic and modern medicine specialists. The review also provides a comprehensive insight to





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the common causative factors, pathophysiology, clinical manifestations, and the management of corneal ulcer through ayurvedic interventions. The publications reveal the available evidence-based information regarding utility, efficacy, and safety of wide spectrum of ayurvedic formulations in the treatment of corneal ulcer. It also highlights the need of conducting clinical trials on ayurvedic medicines with large sample size. *Jalaukavcharan* has been selected as the intervention which has significant results. *Triphala Ghritpan* is also one of the easiest ways to arrest the progression of corneal ulcer to next stage and to speed up the recovery phase. This article summarizes that there is a need to do more research on the ayurvedic treatment of corneal ulcer as well as to publish it because there is very less data available online. So, it is imperative that health care providers across specialties work together so that these patients may have the best possible outcome and avoid many potential complications.

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Table1

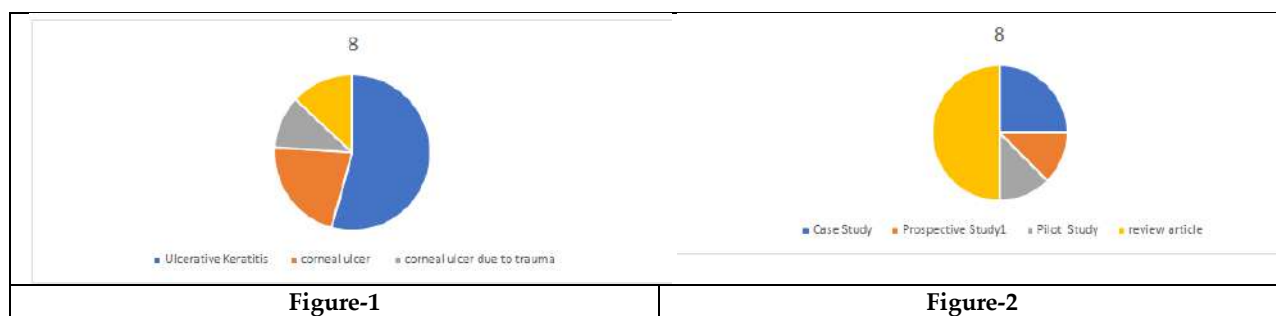
Case	Intervention
Case 1	<ul style="list-style-type: none"> • Jalaukavcharan • Rajanyadi Ashchyotana





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Case 2	<ul style="list-style-type: none"> • TriphalaGhritAbhyantar Pan
Case 3	<ul style="list-style-type: none"> • Virechana • Jalaukavcharan • Seka Therapy • Tarpan Therapy • Anjana Karma • Shaman Aushadhi





Management of Covid Crisis in Hospitals

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ABSTRACT

The COVID-19 Pandemic brought with itself unparalleled challenges for hospitals across the world, heralding a new era of managerial intervention in hospital administration tasked to address and contain its manifestation within the available resources and stipulated timeframe, taking utmost precaution at ground staff in contact level against its rapid spread. The availability of fully committed and dedicated staff for round-the-clock monitoring of patients in a streamlined and synergized roster was the key component of the crisis management effort by hospitals. Having a clear-cut, thoroughly analysed, and well thought in-depth detailed plan, well-chalked-out resource management strategy, and fully synchronized implementation mechanism was critical to the successful functioning of hospitals during the pandemic period under the focused and ingenious administrative hierarchy.

Keywords: COVID Management, Hospital Administration, Pandemic Period, Research Outcome.

INTRODUCTION

COVID crisis exposed the administrative and functional loopholes of the hospitals, presenting a unique opportunity to evaluate and restructure the existing processes, and procedures and institutionalize medical standards and norms



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to cater to emerging dynamic medical situations and management of crises of such humongous proportion and magnitude. The resilience of mandated hospital infrastructure was tested to its brink, stretching it beyond the designed capacity and capability visualized under normal circumstances and formalized keeping the routine patient intake under consideration. The fault lines of hospitals concerning their emergency response mechanism and pandemic preparation level lie bare to the national scrutiny, highlighting the grey areas of concern that warranted immediate de-novo-look. The commitment and devotion to duty demonstrated by the majority of the hospital staff was unheard of earlier and has set a new benchmark for service to humanity during a global crisis, having unprecedented ramifications in terms of loss of lives and health with cascading demoralizing effects on the affected population. With rising COVID cases in India during the first wave of the pandemic, the abinitio response of hospitals was highly chaotic and constrained due to the deeply ingrained mindset of a complacent lackadaisical approach to handling a crisis. Hospital administrations were not only ill-prepared in terms of plan formulation and channelizing required resources within the desired timelines but, were also acutely deficient in available information concerning the natural history of the disease and its continuously evolving mutant versions.

The role played by the World Health Organisation in coordinating the global research effort and timely dissemination of its outcome and the Indian Council of Medical Research (ICMR) in local vaccine development program and its timely approval, as well as continuous revision of treatment protocol and guidelines, were the cornerstone in the successful fight against pandemic by the Hospitals. The crumbling hospital support services due to the sudden downfall in the availability of trained manpower gradually came to life by the emerging pool of volunteers as more and more information was available which motivated the society at large to come together and fight the crisis with collective social resolve. Post-lockdown hospitals started to augment their resources in terms of men, materials, machines, medicine, and money to prepare themselves in a better manner to effectively manage the crisis without leaving any administrative or managerial aspects unaddressed. They coordinated all COVID-related protocols and guidelines to establish a tight, disciplined, and stringent regime of attending and treating patients without compromising on the health of their staff in contact. The Ministry of Health, Government of India in conjunction with the Union Ministries of Chemicals & Fertilisers and Railways ensured the timely availability of testing kits, protective equipment, medicines, and continuous oxygen supply in deficient states during the peak crisis period in different waves of the pandemic. Having received all possible help and support from both Central and State Governments, hospitals made themselves more resource-efficient and patient-friendly to take on the challenges the Virus threw at them with a pragmatic and proactive approach.

The continuously evolving government policies and effective coordination with hospitals and other healthcare providers could help the country to establish a potent counter mechanism against the spread of the Virus. This involved the creation of institutionalized screening procedures at selected entry and exit points, quarantine and isolation facilities at key locations, and standardized treatment protocol as per the research outcomes and ICMR guidelines. Hospitals scaled up telemedicine and online consultancy efforts to cater to less serious patients who could be treated at home without the necessity of in-person contact with doctors. Hospitals gradually increased the stock of Real-Time Reverse Transcription Polymerase Chain Reaction (RT-PCR) and Rapid Antigen Test (RAT) kits to provide their laboratories the wherewithal to test and recommend treatment of infected patients at such a large scale. Regular briefings of the Ministry of Health, Government of India clarified pertinent doubts of the hospitals and helped them to streamline their modus - operandi for treatment of infected cases.

MANAGEMENT OF FIRST WAVE

The first wave of the COVID-19 pandemic brought with itself multifarious challenges for the nation in general and hospitals in particular. Initial understanding of the virus was acutely limited and archaic based on historical facts, especially about the "Spanish Flu". The information available on its origin, etiology, and virulence was inadequate for healthcare professionals at hospitals to begin their counter-preparation by adhering to a specific direction and line of treatment to be effective promptly. It was not at all clear in the initial stage whether the spread of the virus would be restricted at the endemic level or would assume pandemic proportions. As the situation evolved and awareness improved the preparation level at hospitals also progressed accordingly. The Standard Operating



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Procedures (SOP) were continuously revised to keep pace with the rising cases and infected footfall at hospitals impinging upon the limited resources available. The imposition of the Lockdown however helped the hospitals to rapidly augment their human and material resources within the available timeframe to be able to negotiate the relatively slow rise of cases due to containment which increased exponentially post the Lockdown. Hospitals focussed their preparation on the directions received from the Ministry of Health, Government of India, and the research outcomes and findings under the WHO framework. As per the initial assessment and directions received from the Ministry of Health, Government of India, hospitals established their course of treatment for infected cases, primarily based on Paracetamol and Hydroxychloroquine Tablets which were also widely accepted and used worldwide especially in Western Countries, in the absence of any concrete research finding on the Virus. The availability of volunteer doctors, nurses, and other support services staff was the biggest challenge for hospitals, as a large number of existing employees stopped coming to duty due to the prevailing fear in the social environment.

The other major challenge was providing protective equipment to the staff i.e. Mask, Personal Protective Equipment (PPE) Kit, and Gloves. The non availability of any vaccine for even the healthcare professionals at this stage further compounded the problem, however, the lockdown provided hospitals some preparatory time to galvanize the resources and augment their supplies relevant to the Pandemic. Government hospitals with their wider reach and penetration even in the remotest rural areas took the lead at this juncture and other private hospitals in urban centres joined hands to fight the situation in a coordinated manner and provide relief to a large section of the population. One major challenge being faced by the hospitals at this stage was the inadequacy of COVID-19 Testing Kits which made it extremely difficult to segregate symptomatic or asymptomatic positive cases from non-infected cases with flu-like symptoms. Gradual build-up of the kits with rising production led to some respite at the later stage which however couldn't resolve the issue completely as the kits were not giving 100% accurate results. Certain degrees of ambiguity remained throughout regarding the efficacy of testing results; however, the only way cases could be controlled was through large-scale testing and isolation of positive cases in institutionalized quarantine and isolation facilities. When the positive cases started reporting in numbers beyond the capacity of hospitals, the less serious patients were advised to follow the treatment regime under self-isolation at home. At one point in time, there was a shortage of beds in the hospitals to accommodate even the acutely sick COVID patients.

This was the time when less known and poorly rated hospitals were also oversubscribed and patients were dying due to lack of treatment and because of not fully adhering to the standard precautions and treatment protocols promulgated by the Government. The hospitals were waiting eagerly for the successful launch of vaccines which were still at different stages of trials in different countries. In September 2020, COVID-19 cases peaked and the temporary hospitals built by different government departments from within their resources came in very handy, A case in point is railways which converted many of its trains in the yard into hospitals. Even the defence and paramilitary forces contributed significantly with their hospitals, quarantine and isolation facilities, and trained medical personnel. State Governments were also doing their bit in augmenting the resources of District Hospitals as well as Medical Colleges and Hospitals. This wave of pandemic turned out to be the battle of resources against time and the fault lines of hospitals in this regard were fully exposed. Hospital Management was found fighting this battle on a day-to-day basis and eventually succeeding in seeing off the first wave with steely resolve and by plugging most of its functional loopholes. They had learned a lesson of their lifetime that probably eluded the previous generations of managers and which made them stronger and better positioned to handle the ultimate crisis of human existence.

MANAGEMENT OF OXYGEN SUPPLY IN THE SECOND WAVE

The second Wave of the COVID Pandemic was marred by a shortage of Oxygen Supply in the hospitals due to the acute lung infections observed in most of the serious patients, requiring them to be placed on ventilators. By this time vaccination programs especially with indigenously produced COVISHIELD (Developed by Oxford AstraZeneca) and COVAXIN (Developed by Bharat Biotech) Vaccines were in full swing. Also, the production of ventilators was at its peak due to the active involvement of big local brands making it easily available to hospitals.



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The only problem was the large number of positive cases reporting with urgent need for oxygen. The Central Government played a crucial role in managing this crisis and dedicated railway wagons were earmarked to transport oxygen from industrial cities with surplus oxygen to the deficient cities. This wave saw the maximum number of fatal casualties in the hospitals either due to lack of beds or due to lack of oxygen. Industrial units having captive oxygen plants were directed by the government to ramp up production and many tertiary-level government hospitals were provided with new high-capacity oxygen plants for 24 x 7 dedicated oxygen supply to critically ill patients. Later, many patients having been treated with oxygen supply through ventilators reported symptoms associated with “Black Fungus” and the same was dealt with effectively by the hospitals. Another challenge faced by hospitals during this wave was the shortage of one medicine very important for fighting the SARS-CoV-2 virus, the “Remdesivir Injection”. This injection was prescribed by the doctors as it was internationally proclaimed by researchers to be highly successful in treating the virus. A sudden rise in demand made the injection unavailable in the market as hoarders used this opportunity to black-market the injection for exponentially high prices. As the situation deteriorated the Central Government again pitched in and the Ministry of Chemicals and Fertilisers ensured that the local production of Remdesivir Injection was increased by Pharma Companies to meet the growing demand. The situation stabilized in some time and hospitals were able to treat the patients effectively without having to wait for the availability of injections in pharmacy. This wave of the Pandemic saw a synchronized, synergised, and coordinated effort by the Government Agencies, Private & Public Sector Industries, and Hospitals (Government & Corporate) to neutralize the virus during its peak period when resources were overstretched and the affected population started to lose hope.

RECOMMENDATION

1. Hospitals must have their Standing Order Procedures in place for smooth functioning during a crisis with options for multiple contingencies worked out in threadbare details and rehearsed in mock scenarios where applicable.
2. Emergency recruitment and selection plans must be formulated and sources identified for each vertical and job head to cater for sudden absenteeism or mass exodus during a critical requirement period. The process itself should be designed to incorporate parameters of unflinching devotion to duty under testing circumstances.
3. Wherever possible captive training programmes for qualifying courses must be conducted to augment the available pool of qualified candidates for selecting people with institutional affiliation having greater chance of retention during emergent medical situations.
4. Resource management must be given higher priority for maintaining the optimum level and balance between the requirements and holding state in terms of men and materials.
5. Additional incentives must be declared for employees continuing to serve during adverse circumstances to enhance the general morale of people who are on the edge or in dilemma.
6. Additional corpus must be earmarked for emergency procurement of medicines, kits, equipment, or any other resource necessary to tackle specific contingencies to avoid delay and loss of precious lives
7. Psychological conditioning of employees must be ensured at regular intervals to keep them focussed and dedicated towards their charter of duties without getting unduly perturbed by popping up adversities.

CONCLUSION

Hospitals were the focal point of the fierce counter-offensive launched by the Nation against COVID-19 Virus despite the multi-pronged difficulties faced by them during the preliminary stages of the Pandemic. They were instrumental in thwarting the impact of this global health crisis to a great extent by channelizing all their resources and energy to minimise the loss of precious life and reduce the negative impact on the health of the affected population. A medical emergency of such large-scale implications was not heard of in near history in any part of the world. The global





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effort to tackle this crisis boiled down to the performance of various types of hospitals situated in the length and breadth of the geographical areas under effect. Hospitals restored the faith of the citizens in the medical system by putting in tremendous effort at an unprecedented level, standing tall even during the highest point of the pandemic period. The inspirational individual and group performance by some of the hospital staff and healthcare workers stole the heart of the nation, driving them with pride and positive emotion thus infusing high morale. The camaraderie generated by these instances motivated the fearful people to bring in the never-say-die spirit and convinced them to never give up on hope. The benchmark established by the Hospitals in tackling this global pandemic reaffirms the faith of the population in the resilience of the healthcare system. The near superhuman effort by the healthcare professionals and support services staff ensured that Hospitals are treated by the general public as sanctum sanctorum of life-saving effort. Hospitals not only earned tremendous social goodwill but also made handsome fiscal gains due to near absolute bed occupancy during the pandemic period. Hospital management used this opportunity to revamp the systemic mechanisms and methodologies by bringing in new concepts and creating a new visionary roadmap for growth and expansion keeping humanitarian values and principles of patient welfare in the forefront. They understood the essence of healthcare in its contribution towards maintaining a disease-free environment and a healthy society. The contribution made by Hospitals will never be forgotten in centuries to come as historians are better oriented and empowered now towards possession of relevant data with near precise accuracy and factual understanding of the situation. The management of hospitals despite facing an uphill task of handling the situation during the pandemic period didn't allow complacency to set in and lack of idea or strategy to derail the unprecedented effort. The comprehensive and holistic approach for the simultaneous tackling of emergent requirements made certain hospitals stand out among the finest few in various states and union territories. With the singular mandate of safeguarding the lives of every patient admitted, the Hospitals didn't let down the country even during the peak of pandemic.

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Public Awareness Attitude and Suggestions on Generic Medicines

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ABSTRACT

People have used medications for ages. For a number of disorders, modern medications have supplanted traditional ones over time. Generic medications are less expensive than brand-name medications. Generic medications are a recognised and significant source of brand-name drug rivalry as well as a key innovation for the pharmaceutical industry's drive to cut costs. There is much evidence in the literature that members of the medical community, such as doctors and chemists, are important in the promotion of generic medications. Therefore, health care professionals need to take a more active role by educating and suggesting generic drugs more frequently in addition to activities geared to educate potential users about generic medicines. This study concentrated on the public's knowledge and attitudes towards generic medications.

Keywords: Generic, Brand medicine, awareness, competition, traditional medicine

INTRODUCTION

In terms of dosage, form, strength, safety, mode of administration, quality, performance, characteristics, and intended use, generic medications are bioequivalent to innovator- or product-brand name medications. Other manufacturing firms typically submit requests to the drug regulatory agencies for permission to market the generic



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copies of the original pharmaceuticals after the patent term for the original product expires. Non-proprietary names or brand names are used to market generic medications. The drug molecule is marketed under a name that combines the manufacturer name with a non-proprietary name. Globally, the usage of generic medications is growing quickly as a result of financial strain on medical budgets in the form of out-of-pocket expenses. Since they are less expensive than brand-name medications, generic drugs provide the potential for significant health care cost savings.

Statement of the Problem

A generic drug is identical to its brand-name equivalent in terms of dosage form, quality, safety, strength, route of administration, performance, and intended purpose. A favourable mindset towards a product may result in favourable behaviours and a greater propensity to use that thing. Understanding consumer factors that lead to the usage and substitution of generic medications could help us better understand and influence how people buy these drugs. The study set out to assess consumer attitudes about generic drug substitutes and their relationship to consumer behaviour.

Objectives of the Study

- ❖ To analyse the **factors influencing the users** to adopt generic medicines.
- ❖ To investigate the **level of satisfaction on generic medicines** among respondents

REVIEW OF LITERATURE

Venkatesh V. Khadke et al. (2017) in their study analysed beliefs, obstacles, awareness, and actual practises of the doctor about the usage of generic medications. On a sample of 300 randomly chosen Rural Medical Practitioners working in Nanded, Maharashtra, a cross-sectional survey was done.

Susmitha Vemu et al. (2019) in their study emphasised on the Rural medical professionals' attitudes, knowledge, and practises regarding generic drugs. By taking advantage of gaps in the public health system, rural medical practitioners are able to practise extensively there. More than 80% of respondents said they were equally effective and safe as their branded competitors and were cost-effective.

RESEARCH METHODOLOGY

Coimbatore district, known as the Manchester of South India is famous for textiles has been the spot light of the study. Both primary and secondary data has been collected for the study. One third of the shops had been selected on convenience basis. 30 samples were collected from each shop. The collected data have been used for analysis with the help of statistical tools.

- Percentage Analysis.
- Garrett Ranking Techniques.
- ANOVA.

Limitations of the Study

1. The study towards the generic medicines in Coimbatore District may not be generalised to other districts.
2. There are several medications and the results of the study may not be applicable to other medications such as allopathic, homeopathy, siddha and unani etc.
3. The research focused in generic medicines users' opinion at a specific time and within a specific environment which may vary from time to time and one environment to other.

Analysis and Interpretation





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Factors influencing the users to adopt generic medicines - Garrett Ranking

S. No	Reasons	Total score	Garrett's Mean score	Rank
1	Easy availability of medicines	23028	38.38	VIII
2	Quick recovery	24527	40.88	VI
3	Low cost	24731	41.22	IV
4	Less side effect	25133	41.88	I
5	Local medicine	24313	40.52	VII
6	Effective for chronic diseases	21804	41.34	III
7	Past experience	24646	41.07	V
8	Quality	24837	41.39	II

Source: Computed

The table indicates the various factors that influence the users to adopt generic medicines in Coimbatore Region. The study revealed that the **Less side effect** was ranked first, **Quality** was ranked second and **Effective for chronic diseases** was ranked third, pointing out that these are the major factors influence the respondents to adopt generic medicines whereas **Quick recovery** was ranked sixth, **Local medicines** was ranked seventh and **Easy availability** of medicines was ranked last, pointing out that these are the factors influencing the respondents to adopt for generic medicines.

Awareness of Generic Medicines

Source of Awareness	No. of Respondents	Percentage
Physician	41	6.7
Pharmacist	138	22.4
Family and friends	315	51.2
Media	78	12.7
Internet	43	7.0
Total	615	100.0

Source: Computed

According to the aforementioned table, of the 615 respondents, 51.2% had heard of generic medications from family and friends, 22.4% had learned about them from chemists, 12.7% had learned about them from the media, 6.7% had heard about them from general physicians, and 7.2% had received information online. The majority of responders, it may be concluded, had heard about generic medications through their relatives and friends.

Knowledge on Generic Medicine

Use of generic medicines is important to reduce risk associated with health-care and costs. Proper knowledge in Generic medicine is important for the Generic Medicine users to avoid unnecessary health issues.

Knowledge on Generic Medicine

Knowledge on Generic Medicine	Mean	Rank
Generic Medicine contain the active substance as other medicine	3.50	II
Generic medicine only be marketed after the expiry date of patented drug	4.26	V
Generic medicine can be used at the same dose for same disease	4.48	VII
Pharmacist offers Generic Medicine with awareness	3.84	III
Greater knowledge in Generic Medicine leads to Greater use	3.20	I
Aware of Jan Aushadh Kendra	4.25	IV
Patients and chemists are legally permitted to buy and sell generic medications in place of those that are prescribed to them.	4.46	VI





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Source: Computed

The users with **“Greater knowledge in Generic Medicine”** lead to Greater use have been the most important knowledge of Generic Medicine, which has been scored a mean value of 3.20. The next important factor has been the **“Generic Medicine contain the active substance as other medicine”** of the Generic Medicine users, (mean value 3.50). The **“Pharmacist offers Generic Medicine with awareness”** has been knowledge influenced the users’ to have more awareness and has a mean value 3.84. **“Aware of Jan Aushadh Kendra”** scored 4.25 has been considered as next rank followed by **“Generic medicine only be marketed after the expiry date of patented drug”** with the mean value of 4.26 **“Patients and chemists are legally permitted to buy and sell generic medications in place of those that are prescribed to them”** and **“Generic medicine can be used at the same dose for same disease”** have been ranked as the least important factors with the mean values 4.46 & 4.48 respectively.

Kendall's Coefficient of Concordance

Kendall's W	0.053
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The above test has been implemented to find out the extent of similarities among the users in the order of assigning the ranks.

W will range from 0 – 1. Higher the value of W more will be the similarity among the respondents in the order of assigning the ranks. The table value was found to be 0.053, which shows that there is little similarity among the Generic Medicine users in giving preference to the knowledge about the Generic Medicines.

Occupation and Users' Level of Agreeability on Suggestion towards Generic Medicines

Factors	Variables	Occupation						Total	F value	P value	Result
		Private Emp'ee	Govt. Emp'ee	Housewife	Agri	Business	Stud				
Advertising strategy may be improved	Strongly Agree	34	7	11	19	26	4	101	2.230	0.050	Accepted
	Agree	101	33	38	43	69	10	294			
	Neutral	58	18	16	20	28	5	145			
	Disagree	16	6	6	12	11	1	52			
	Strongly Disagree	4	8	0	7	3	1	23			
<ul style="list-style-type: none"> Government should take measures to increase awareness of generic drugs to the general public 	Strongly Agree	46	10	21	26	29	5	137	0.839	0.522	Accepted
	Agree	109	49	29	40	60	5	292			
	Neutral	40	6	16	20	35	8	125			
	Disagree	13	6	4	9	10	3	45			
	Strongly Disagree	5	1	1	6	3	0	16			
<ul style="list-style-type: none"> Reduce illicit medical practices 	Strongly Agree	32	4	13	21	23	4	97	0.901	0.480	Accepted
	Agree	93	43	32	44	61	9	282			
	Neutral	44	9	17	23	27	4	124			
	Disagree	34	8	7	7	15	3	74			
	Strongly Disagree	10	8	2	6	11	1	38			





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Medical Council of India instructs the doctors to prescribe generic medicines.	Strongly Agree	48	3	14	21	35	6	127	3.956	0.002	Rejected
	Agree	101	36	35	47	48	7	274			
	Neutral	39	11	10	15	27	5	107			
	Disagree	20	11	8	12	18	2	71			
	Strongly Disagree	5	11	4	6	9	1	36			
Government should control the MRP of drugs to benefit the common man	Strongly Agree	63	5	17	22	35	8	150	3.342	0.005	Rejected
	Agree	80	34	29	46	61	7	257			
	Neutral	26	14	9	21	16	1	87			
	Disagree	35	6	13	10	24	4	92			
	Strongly Disagree	9	13	3	2	1	1	29			
The IMA should also take measures to ensure quality, safety and affordability of generic drugs	Strongly Agree	79	13	21	27	47	5	192	6.340	0.000	Rejected
	Agree	76	23	31	36	47	9	222			
	Neutral	21	7	8	10	10	3	59			
	Disagree	30	8	10	23	24	4	99			
	Strongly Disagree	7	21	1	5	9	0	43			
More steps to strengthen the Jan Aushadhi scheme	Strongly Agree	50	9	16	23	24	5	127	0.753	0.584	Accepted
	Agree	93	39	35	50	80	11	308			
	Neutral	37	13	13	16	19	2	100			
	Disagree	22	7	5	9	12	2	57			
	Strongly Disagree	11	4	2	3	2	1	23			
Measures should be taken to control the doctor-big pharma nexus	Strongly Agree	72	18	19	27	34	4	174	1.004	0.414	Accepted
	Agree	93	28	33	52	78	10	294			
	Neutral	30	18	16	14	18	6	102			
	Disagree	10	4	2	6	2	1	25			
	Strongly Disagree	8	4	1	2	5	0	20			
Encourage more and more private companies / individuals to open generic drug stores	Strongly Agree	69	7	21	24	42	7	170	1.708	0.131	Accepted
	Agree	85	39	26	44	51	6	251			
	Neutral	24	12	13	18	26	5	98			
	Disagree	26	5	8	10	14	2	65			
	Strongly Disagree	9	9	3	5	4	1	31			
	Total	213	72	71	101	137	21	615			

Source: Computed

It is observed from the above table that the calculated ANOVA values are lesser than the significant level (0.05 level), hence, the null hypothesis is rejected for all the variables except **Advertising strategy may be improved**, **Government should take measures to increase awareness of generic drugs to the general public**, **Reduce illicit**





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medical practices, More steps to strengthen the Jan Ausadhi scheme, Measures should be taken to control the doctor-big pharma nexus, Encourage more and more private companies / individuals to open generic drug stores and it is concluded that there exist a significant difference of opinion with the respondents with various occupational status and the user's level of agreeability on suggestion towards generic medicines.

Findings of the Study

Factors influencing the users to adopt generic medicines – Garrett Ranking

➤ The study revealed that the **Lessside effect** was ranked first, **Quality** was ranked second and **Effective for chronic diseases** was ranked third, pointing out that these are the major factors influence the respondents to adopt generic medicines whereas **Quick recovery** was ranked sixth, **Local medicines** was ranked seventh and **Easy availability** of medicines was ranked last, pointing out that these are the factors influencing the respondents to adopt for generic medicines.

➤ The users with “**Greater knowledge in Generic Medicine**” leads to Greater use have been the most important knowledge of Generic Medicine, which has been scored a mean value of 3.20. The next important factor has been the “**Generic Medicine contain the active substance as other medicine**” of the Generic Medicine users, (mean value 3.50). The “**Pharmacist offers Generic Medicine with awareness**” has been knowledge influenced the users’ to have more awareness and has a mean value 3.84. “**Aware of Jan Aushadh Kendra**” scored 4.25 has been considered as next rank followed by “**Generic medicine only be marketed after the expiry date of patented drug**” with the mean value of 4.26. Second and Seventh factor have been ranked as the least important factors with the mean values 4.46 & 4.48 respectively. Kendall’s coefficient of concordance (W) found for the above items is 0.053, which shows that there is little similarity among the Generic Medicine users in giving preference to the knowledge about the Generic Medicines.

Suggestions of the Study

- ✓ Awareness on Generic Medicine to gain more knowledge on it had linked positive opinion on the use of Generic Medicine and to avoid the negative perceptions of generic medicines among the users.
- ✓ The attitude of Medicine users that costly medicines are of better quality to overcome the health issues need awareness as well as change of attitude towards Generic Medicine.

CONCLUSION

Generic Medicines are important category of medicines in the pharmaceutical market. They are the channels through which the users can be benefited. Generic medicines provide harmless, affordable price medicines to the users. By way of creating awareness among the people to compete effectively with other medicines to expand its presence in current markets and break into new ones. Pursuing policies geared to the promotion of generic medicine India can support at middle income group who form the majority of the population.

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Health care Monitoring System Using LIFI and IOT

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ABSTRACT

The escalating demand for healthcare services in response to the demographic shift is steering the adoption of innovative solutions that integrate IoT (Internet of Things) and Li-Fi technologies. This paper proposes the development of an IoT-based healthcare monitoring system using Arduino and Li-Fi technology. The system's design focuses on monitoring essential vitals and transmitting data to a database via the internet. Li-Fi's capability to facilitate high-speed wireless communication through light ensures a secure and efficient means of transmitting health data. The integration of Li-Fi and IoT allows caregivers and medical professionals to monitor individuals in real-time from any location using dedicated applications. This not only enhances the accuracy and speed of health data transmission but also contributes to the flexibility and accessibility of remote healthcare monitoring. The collaborative power of Li-Fi and IoT signifies a significant advancement in delivering timely and effective healthcare solutions tailored to the needs of the elderly population.

Keywords: Internet of things, Light Fidelity, health care monitoring system , Arduino , Sensors

INTRODUCTION

The UN World Population Ageing 2019 Highlights revealed a global population of 703 million individuals aged 65 or over in 2019, with Eastern and South-Eastern Asia hosting the largest segment at 260 million[1]. This trend is particularly pronounced in Taiwan, projected to transition into a super-aged society by 2026, where at least 20 percent of the population will be 65 or older, as reported by the National Development Council. Technology plays the vital role in the sensory devices in the monitoring of healthcare, communication and recording of data. It is indispensable to monitor the various medical parameters. Hence, the most advanced development in the communication methodology of healthcare, IoT is customized[2]. IoT is a medium for healthcare applications and plays a vital role in many applications. Li-Fi, a wireless communication technology utilizing light for data transmission, emerges as a pivotal element in enhancing healthcare monitoring systems. This paper aims to provide



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necessary attention to elderly people's health and help the doctors or health officials taking care of them to monitor remotely via an application. In this paper, health care monitoring system uses sensors to trace patient health and use the cloud with the help of ESP8266 module to store the data in a database which can be accessed by entering username and password. Essential vitals, including pulse rate, temperature (LM35), room temperature and humidity (DHT11), are seamlessly obtained through dedicated sensors. In a notable enhancement, Li-Fi technology is employed for wireless communication, providing secure and high-speed data transmission. The database access remains secure through a designated security key, allowing for monitoring at any time. This technology proves especially valuable for individuals, particularly the elderly, who reside alone without continuous supervision. Remote access to vital signs enables a prompt response to any health abnormalities. Consequently, the implementation of IoT and Li-Fi is imperative to integrate sensors over a Li-Fi wireless network, and a secure database should be established for data retrieval [3-6].

Hardware Description

Arduino UNO

The open-source Arduino module makes kits with microcontrollers for constructing interactive things and digital gadgets that can sense and operate tangible objects. The module is based on microcontroller board designs made with different microcontrollers by multiple suppliers. The boards have serial connection interfaces for loading software from personal computers, including Universal Serial Bus (USB) on certain models. The Arduino module offers an integrated development environment (IDE) for microcontroller programming that is based on the Processing programming language, which is also compatible with C and C++.

20 x 4 Liquid Crystal Display

LCD (Liquid Crystal Display) is a display unit with flat panel, using liquid crystals for its working such as the display of characters, number, special ASCII characters etc. They come in variety of sizes such as 8x2, 10x2, 16x2, 16x4, 20x4 etc.

ESP 8266

The network of commonplace items that are integrated with electronics, software, sensors, and connectivity to facilitate data exchange is referred as the Internet of Things, or IoT. With its highly integrated Wi-Fi SoC, Espressif System's ESP8266EX satisfies users' ongoing needs for dependable performance, small size, and economical power consumption in the IoT sector.

Pulse sensor

An excellent plug-and-play heart rate sensor for Arduino is Pulse Sensor, which comes with an open-source monitoring program displaying a real-time pulse graph. The side that comes into contact with the skin is the one, with the heart emblem on the front.

Photoresistor

A photoresistor is a sort of resistor that adjusts its resistance based on the quantity of light it receives. It is also referred to as a light-dependent resistor (LDR). They are used in various applications, such as light sensors, alarms, switches, and cameras. It consists of a high-resistance semiconductor material that absorbs photons and generates free electrons. The more the light that falls on the device, the lower the resistance. It has a low power consumption and does not produce significant heat.

Temperature Sensor

Temperature may be measured more precisely with an LM35 than with a thermistor, as the sensor circuitry is sealed, oxidation and other processes cannot affect it. It also has a poor self-heating capacity and raises the temperature in still air by no more than 0.1 0C.





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Laser Light

Laser light plays a crucial role in the Li-Fi technology implementation. Li-Fi utilizes laser light for wireless data transmission, offering high-speed communication through light signals. In the context of healthcare monitoring, laser-based Li-Fi enables the transmission of vital health data in a secure and efficient manner. This technology enhances the capabilities of the IoT-based monitoring system, allowing for real-time data streaming of patients' vital signs. The precision and focused nature of laser light contribute to the reliability of data transmission, ensuring that healthcare professionals can receive accurate and timely information for monitoring and responding to patients' health conditions. The integration of laser light in Li-Fi technology, within the broader framework of IoT, marks a significant advancement in healthcare monitoring, offering a reliable and high-speed communication channel for transmitting critical health data in real time.

Software description

In this healthcare monitoring system using Li-Fi and IoT, the Arduino Integrated Development Environment (IDE) is employed for programming an Arduino Uno board, facilitating seamless communication and coordination between various health sensors. The code is written in C++ and utilizes embedded C to process the sensor data efficiently. This information is then transmitted via serial communication, either visually represented in the Arduino Serial Monitor or sent to an external system, depending on the user's preference. The Li-Fi technology enhances the security and speed of data transmission between the healthcare monitoring system and external applications, providing real-time monitoring capabilities using IoT. Overall, the system efficiently combines embedded C programming, sensor data processing, IoT and Li-Fi technology to create a robust and versatile healthcare monitoring solution.

Transmitting end

This Arduino code integrates various sensors and components to create a comprehensive health monitoring system. The flow chart of the transmitting end is shown on Figure 1. It incorporates a DHT11 sensor for measuring temperature and humidity, an LM35 temperature sensor, and a pulse sensor interfaced with interrupt-driven pulse detection logic. The system utilizes Li-Fi technology, represented by a laser diode controlled by pin 7, for wireless data transmission. The heart rate, measured by the pulse sensor, is calculated in beats per minute (BPM). The gathered data is transmitted serially and visually monitored via the Arduino Serial Monitor. The integration of Li-Fi technology, Arduino, and various sensors creates a versatile health monitoring system capable of real-time data transmission and analysis, crucial for remote healthcare applications.

Receiving end

The flow chart of the transmitting end is shown on Figure 2. This Arduino code establishes a health care monitoring system that reads analog data from a photoresistor (connected to pin A0) to detect changes in ambient light. The system uses a threshold value to distinguish between light and shadow conditions. When the light exceeds the threshold, the code captures a series of bits representing sensor data and converts them into characters. These characters are then organized into arrays corresponding to humidity, temperature, body temperature, and heart rate (BPM). The data is displayed on a 20x4 LCD screen and transmitted to the Ubidots cloud platform using the SoftwareSerial library. The code employs the ArduinoJson library to structure the data into a JSON format before transmission. The LCD display and serial monitor output provide real-time visualization of the sensor readings, offering insights into environmental conditions and health parameters.

ESP8266-Based IoT Device

This code is designed for an ESP8266-based IoT device to collect health-related sensor data and transmit it to the Ubidots cloud platform using the Ubidots library. The code establishes a connection to a Wi-Fi network and the Ubidots cloud using the ESP8266WiFi and Ubidots libraries. The flow chart of the Wi-Fi module is shown on Figure 3. The device reads sensor data, including humidity, temperature, body temperature, and heart rate (BPM), from a Software Serial connection (pins D5 and D6). It then retrieves this data from the Ubidots cloud platform, printing the received values for each parameter if they are non-zero. The program sends this data to Ubidots in a structured JSON



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format, facilitating efficient communication with the cloud. The loop continuously collects and transmits sensor data to Ubidots, ensuring real-time monitoring and analysis of health-related metrics in the cloud platform. The serial output provides information about the received data and the status of data transmission to Ubidots.

System design

A control unit is used to collect data from various sensors. The collected data is converted into light signals with the help of control units. These light signals are then transmitted with the help of LED transmitter. The pulse of light is transmitted to the photoresistor sensor, which is a device that can convert light into electrical signals. These electrical signals are converted into actual data with the help of a control unit. A LCD display is used to display the actual data. Figure 4 illustrates that a variety of medical sensors, such as LM35 for temperature monitoring, a pulse sensor for heart rate measurement, and a DHT11 for humidity and temperature sensing, are attached to the patient, capturing a comprehensive set of health metrics. An Arduino microcontroller serves as the central processing unit, aggregating and managing the data acquired from these sensors. The compiled data is then transmitted to a photodiode sensor through an LED transmitter, utilizing light signals as a communication medium. Another Arduino microcontroller, potentially aided by an ESP8266 module for wireless connectivity, receives and decodes these light-encoded signals, converting them back into interpretable data. This processed data, which includes data from LM35, pulse sensor, and DHT11, is subsequently dispatched to a cloud platform for thorough analysis and storage. Crucially, an alerting mechanism is integrated into the system, triggering notifications on an LCD display if the sensors detect data falling below a predefined threshold. This alerting system ensures real-time monitoring and immediate intervention in case of a potential health emergency, enhancing the overall effectiveness of the health monitoring setup. The Hardware implementation of the system is shown in the figure 5

Cloud

A healthcare monitoring system leveraging Li-Fi (Light Fidelity) and IoT (Internet of Things) incorporates a sophisticated infrastructure for real-time data processing and analytics. In the realm of real-time data streaming, patient vitals, such as heart rate, body temperature, room temperature & humidity, are continuously transmitted from IoT-enabled devices like wearables or medical sensors. This seamless and low-latency data flow is pivotal for healthcare professionals to monitor patients in real time, allowing for swift responses to any deviations from normal health parameters. The integration of Li-Fi technology, utilizing light signals for data transmission, can further enhance data transfer speed and reliability in healthcare environments. The system's data analytics component plays a crucial role in gleaning meaningful insights from the influx of patient data. Through predictive analytics, healthcare providers can analyze patterns to forecast potential health issues or identify trends in the health of a population. This capability enables early detection of health problems, facilitating proactive and personalized healthcare interventions. Moreover, the utilization of machine learning algorithms in data analytics can contribute to resource optimization in healthcare facilities, improving operational efficiency and patient care. Data visualization tools are employed to represent patient data in graphical formats, aiding healthcare professionals in interpreting complex information swiftly and accurately.

This visualization aspect is particularly valuable in presenting patient health status in an easily understandable manner, allowing for rapid and informed decision-making. Figure 6 shows the Ubidots platform with the display of digital value of various sensors at every moment and pictorial view of the data for a given period. In emergency situations, visualizations can be instrumental in providing a quick overview of a patient's condition, enabling healthcare providers to take immediate actions. The implementation of alerts and notifications is critical for a healthcare monitoring system, where timely responses to critical events can be life-saving. Alerts can be customized to notify healthcare professionals in real time when a patient's vital signs deviate from the normal range or when specific health conditions demand immediate attention. This proactive approach ensures that healthcare providers can swiftly respond to critical situations, improving patient outcomes and potentially preventing medical emergencies. Efficient data storage is fundamental for securely retaining patient records, historical health data, and other relevant information. This organized storage supports longitudinal studies, facilitates retrospective analysis of



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patient history, and ensures that healthcare providers have access to a comprehensive patient profile for informed decision-making. It also aligns with data privacy and security standards, safeguarding sensitive healthcare information.

DISCUSSION

In summary, a healthcare monitoring system that integrates Li-Fi and IoT technologies establishes a robust ecosystem for real-time data processing, analytics, visualization, alerts, and efficient data storage. The ESP8266 module plays a pivotal role in implementing the IoT framework, requiring connection to a wireless network through the appropriate SSID and password settings. This proposed healthcare monitoring system incorporates vital sensors such as a temperature sensor (LM35), pulse sensor, room temperature and humidity sensor (DHT11). The Arduino continuously collects data from the sensors and transfers the information to a dedicated database at predefined intervals. The programming of the Arduino involves the use of embedded C, where conditional statements are employed to classify the gathered data as either normal or abnormal. This holistic approach contributes to improved patient care, streamlined healthcare processes, and better overall health outcomes by leveraging advanced technologies to their full potential.

CONCLUSION

In this work, the innovative concept of remote health monitoring is introduced, leveraging the power of both Li-Fi and IoT technologies. Biomedical sensors are seamlessly integrated with an Arduino platform for efficient data computation and transfer. What sets this system apart is its ability to utilize Li-Fi technology, ensuring secure and high-speed communication between the healthcare monitoring system and the database. This technological integration enhances the overall reliability and efficiency of the monitoring process. To access patient data stored in the database, doctors or caretakers simply need to log in with their assigned username and password. This approach facilitates streamlined and secure remote monitoring, offering healthcare professionals real-time insights into patient well-being.

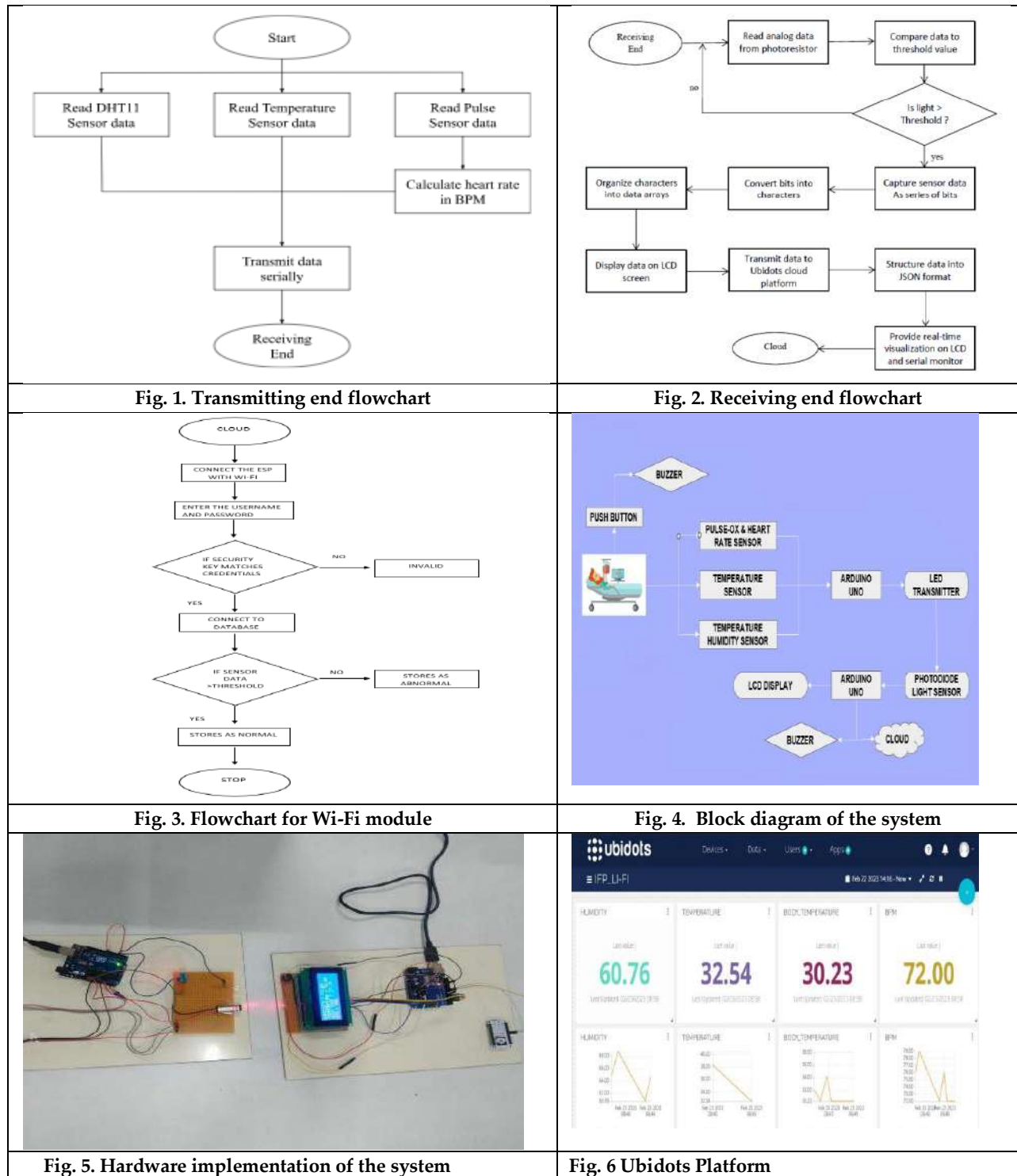
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Case Study on Narcotic Drugs and Psychotropic Substances

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ABSTRACT

The Narcotic Drugs and Psychotropic Substances Act, 1985, stands as a crucial legislative milestone in India, governing the creation, possession, sale, transportation, and use of narcotic drugs and psychotropic substances. This article investigates into the historical, legal, and practical facts of the Act, outlining its evolution and examining its impact. Prior to 1985, India had no narcotics legislation, and the cultural acceptance of substances like cannabis had prevailed for centuries. This study explores the highlighting significant amendments introduced and specifically focus on the recent proposal to decriminalize personal drug possession. A critical component of this case study is an in-depth analysis of a real legal case involving the export of 'Non-Woven Shopping Bags' to Malaysia. During a customs inspection, white powder suspected and found hidden in the bag handles. This case emphasizes the pivotal role of forensic evidence and the burden of proof in drug-related legal proceedings. This study offers a comprehensive overview of the complexities and challenges inherent in prosecuting narcotic drug-related offenses within India's legal landscape.

Keywords: Cannabis legalization in India, Decriminalization of personal drug possession, Legal case, Forensic evidence, Drug trafficking in India, Controlled substances, Narcotic substances.



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INTRODUCTION

India has a legislation that forbids the production, manufacturing, cultivation, possession, sale, transit, storage, and use of narcotic narcotics and psychotropic substances. This law is known as the Narcotic narcotics and Psychotropic Substances Act, 1985[1]. The Single Convention on Narcotic Drugs and other international accords are aimed at combating drug trafficking through the Act, which is applicable to all Indian nationals, non-Indians, and registered ship and airline passengers [2].

Background [3]

Since 2000 BC, people in India have used marijuana, although there wasn't a drugs statute in effect until 1985. According to the Indian Hemp medications Commission, moderate use of hemp medications is not harmful, but excessive usage is. Up until 1985, cannabis and its derivatives could be legally bought, and recreational use was common. India resisted the US's call for a worldwide ban on drugs for 25 years. The NDPS Act, which made all drugs illegal in India, was passed by the Rajiv Gandhi administration in 1985.

Definitions [4]

Narcotic Drugs The word "narcotic" has a very different meaning in the legal environment than it does in the medical context, where it refers to a substance that induces sleep.

Legally, narcotic drugs include opiates, which are actual narcotics, cannabis, which is not a narcotic, and cocaine, which is the exact opposite of a narcotic because it is a stimulant.

Psychotropic substances The word "psychotropic substance" refers to depressants like Lysergic phencyclidine, amphetamines, barbiturates, methaqualone, acid diethylamide [LSD], and designer drugs [such as MDMA and DMT]

Classification [4]

Illegal drug popular in India:[4]

- **Heroin:** Opium, Morphine, Cannabis
- **Hashish:** Cocaine
- **Methaqualone:** Amphetamines
- **Psychotropic substance:** Precursor chemicals

Objectives [5]

1. To combine and modify the current drug legislation regulations.
2. To enact strict rules for the management and supervision of activities involving narcotic drugs and psychoactive substances.
3. To significantly increase punishments, notably for crimes involving human trafficking.
4. To establish guidelines for the application of international drug and psychotropic substance treaties to which India is a party.

Authorities and Officers [3]

1. Central Government to take measures for preventing and combating abuse of and illicit traffic in narcotic drugs, etc.
2. Officers of Central Government.
3. The Narcotic Drugs and Psychotropic Substances Consultative Committee.
4. Officers of State Government.





Amendments

NDPS ACT, amendment 1988[6]

The Narcotic Drugs and Psychotropic Substances [Amendment] Act, 1988 [Act No. 2 of 1989] received assent from then President Ramaswamy Venkataraman on 8 January 1989. "The prevention of illicit traffic in narcotic drugs and psychotropic substances act, 1988"[7]

NDPS ACT, Amendment 2001[8]

The Narcotic Drugs and Psychotropic Substances [Amendment] Act, 2001 [Act No. 9 of 2001] received assent from then President K. R. Narayanan on 9 May 2001.

NDPS ACT, Amendment 2014[9]

In 2014, the Narcotic medications and Psychotropic Substances Act brought about substantial modifications to the regulation of essential narcotic medications, making them more available for pain management and palliative care. This amendment also focuses on boosting treatment for persons battling with drug abuse, enabling private sector engagement in opium and intense poppy straw processing, and reinforcing rules linked to asset forfeiture. Notably, it increased the sentence for small drug offenses from six months to one year in jail while eliminating the obligatory death penalty for repeat offenders in situations involving large-scale drug trafficking.

NDPS ACT, amendment 2021[10]

In 2021, the Union Ministry of Social Justice and Empowerment introduced a proposal to decriminalize the possession of small quantities of drugs for personal use. The primary objective is to approach individuals with substance use disorders as victims rather than criminals. A high-level meeting held in November 2021 reached a consensus to eliminate incarceration and fines for personal drug possession and to make amendments to Section 27 of the NDPS Act

Offences And Penalties Under NDPS Act [11]

- Illegal opium, cannabis, or coca plant cultivation harsh punishment: up to ten years of imprisonment and fine up to rupees one lakh under sec 18[c] Opium Coca-Cola: 20 Cannabis section 16
 - Opium abuse by a registered farmer Up to 20 years in jail and a fine of rupees one to twolakhs under section 19[12]
 - Narcotics and psychoactive substances must not be produced, manufactured, possessed, sold, purchased, transported, imported over state lines, exported across state lines, used, or exported. Under section 20, 21, & 22[13–15]
 - Small amount: Up to a six-month jail sentence, a fine of up to rupees ten thousand or both.
 - More than tiny but less than commercial quantities: 10 years in jail or a fine of up to rupees one lakh.
 - Commercial quantity: Penalty of 10 to 20 years in jail or a fine of 1 to 2 lakh rupees Cannabis
1. Importing, shipping, or trans hipping narcotics and psychoactive substances similar to above, under section 23[16]
 2. The term "External dealings" under the NDPS refers to participating in or overseeing transactions involving the supply of pharmaceuticals to a person outside of India from sources outside of India. Imprisonment 10–20 years in prison or a fine of Rs. 1–2 lakh irrespective of the amount under section 24[17]
 3. Contraventions involving restricted substances strict imprisonment of up to 10 years including a fine of Rs. 1–2 lakh under section 25A[18]
 4. Sheltering criminals and funding traffic violations stifling confinement 10–20 years in prison with a fine of £1–2 lakh, under section 27A[19]
 5. Attempts, aiding, and conspiring with criminals identical to the offense Attempts- under section 28, Criminal conspiracy and facilitation under section – 29[20]
 6. Repeat offense one and half times the offense's punishment. Some crimes carry the death sentence. Death, under section 31; 31A[21,22]



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7. The consumption of cocaine, morphine, heroin imprisonment up to one year or fine up to rupees twenty thousand or both. Other drugs imprisonment up to six months or fine up to rupees ten thousand or both. Under 27 immunity section 64A[23]
8. Penalties for infractions that aren't otherwise mentioned Up to six months in jail, a fine, or both under section 32[24]

Small and Commercial Quantities [25]

The punishment varies depending on whether the amount of drugs involved is small, more than small but less than commercial, or commercial for a number of offenses under the NDPS Act. Each drug's little and commercial quantities have been informed. The following are the dosages for some popular drugs:-

Commercial quantity: It refers to any amount more than that specified by the Central Government in a notification published in the Official Gazette when referring to narcotic medications and psychotropic substances.[4]

Small quantity: refers to any quantity that is less than that which the federal government indicated in a statement in the Official Journal[4]

Details of Seizure of Drugs for the Years:**Drug seizures in 2021**

Drug	Cases	Accused	Articles seized [in kg]	Amount [in Rs]
Heroin	8	35	313	1,562cr
Synthetics drugs	102	175	2,746	35cr
Ganja	301	425	63,398	16.54cr
Charas	19	34	85	1.46cr
Opium	20	27	764	83.49 lakh
Total	450	696	67,306	1,617cr

Drug seizures in 2020

Drug	Cases	Accused	Articles seized [in kg]	Amount [in Rs]
Heroin	5	14	36	176 cr
Synthetics drugs	48	86	4,570	7.55 cr
Ganja	220	304	6,659	6 cr
Charas	17	23	267	5 cr
Opium	20	26	927	67lakh
Total	310	453	12,459	195 cr

Definitions

Before look into the case, it is essential to understand key legal terms:

NDPS Act: The Narcotic Drugs and Psychotropic Substances Act, 1985, is an Indian legislation aimed at regulating and controlling operations related to narcotic drugs and psychotropic substances.

Contraband: Goods or substances that are prohibited by law due to their potential for abuse or illegal trade.

Forensic Report: A scientific analysis of evidence, often conducted in laboratories, to determine the nature and composition of substances.

DISCUSSION**Case Study [6]****Brief Facts of the Case**

CASE: ARUN V vs STATE BY INSPECTOR OF CUSTOMS

CRIMINAL PETITION NO.9097/2016

CASE NO: O.R.No.4/2016-17

DATED: 4 May, 2017



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Arun V, aged about 25 years, resides in Bengaluru, Karnataka. The petitioner is facing charges related to the export of 'Non-Woven Shopping Bags' to Malaysia, where white powder, Customs authorities conducted a preliminary test using a narcotics Field Test Kit, suspected to be Methaqualone, was found concealed in the plastic handles of the bags. For a chemical analysis, the samples were submitted to the Custom House Laboratory in Chennai. In accordance with Section 36 A [1] [d] of the Narcotic Drugs and Psychotropic Substance Act, 1985 [NDPS act for short], the respondent has filed a complaint before the Special Court for NDPS cases. Additionally, the complaint was filed under Special C.C. No. 148/2017. The petitioner's statement was recorded, and he had previously been detained. He has been in detention ever then.

The key arguments made by the petitioner's counsel include:

- Challenging the accuracy and validity of the chemical examination report from the Central Forensic Science Laboratory, Hyderabad [CFSL], stating that the report did not specify the details of tests conducted and the percentage of the drug concentration found.
 - Arguing that no qualitative or quantitative analysis was done on the samples, and without such analysis, the complaint filed by the respondent is invalid, citing a judgment from the Hon'ble Supreme Court of India in the case of E. Micheal Raj v. Intelligence Officer, Narcotic Control Bureau.
 - Alleging that the samples sent to CFSL were tampered as they were earlier opened by the Custom House Laboratory, Chennai, and the seals were illegible.
 - Claiming that the petitioner was not in physical possession of the contraband and was merely a name lender for exporting the goods, and, therefore, should not be considered the actual owner and exporter of the goods.
- Under the Narcotic Drugs and Psychotropic Substances [NDPS] Act, 1985, there are provisions for inspections and searches to regulate and control the operations related to narcotic drugs and psychotropic substances. Overview of the inspection procedures under the NDPS Act:

Search and Seizure [Section 41]:[26]

Authorized officers, including police officers and officers of the Narcotics Control Bureau, can conduct searches and seizures when they have reasonable grounds to believe that a person is in possession of, dealing with, or trafficking in narcotic drugs or psychotropic substances in contravention of the Act.

Warrantless Search [Section 42]:[27]

In certain situations, authorized officers can search and arrest without a warrant if they have reason to believe that the delay in obtaining a search warrant might result in the disappearance or destruction of evidence.

Procedure for Arrest and Seizure [Section 43]:[28]

When a person is arrested and articles or substances are seized, the officer making the arrest or seizure must prepare a memorandum, which includes details of the items seized. This memorandum must be signed by at least two independent witnesses.

Detention and Production Before Magistrate [Section 52]:[29]

An arrested person must be produced before the nearest magistrate within 24 hours [excluding the time necessary for the journey]. The magistrate may authorize the detention of the accused in custody for a period not exceeding 180 days.

Forwarding of Seized Substances for Examination [Section 52-A]:[30]

Any narcotic drug or psychotropic substance seized under the Act must be sent for examination to a government analyst or a forensic laboratory to determine its nature and quantity.

Chemical Examination and Analysis [Section 52-B]:

The government analyst or forensic laboratory conducts a chemical examination and analysis of the seized substances to ascertain their composition and quantity. The results of these analyses are crucial for legal proceedings.

Registration of Offenses [Section 55]:[31]

Based on the results of the examination and analysis, if the substance is confirmed to be a narcotic drug or psychotropic substance and if it is being possessed, manufactured, sold, or transported in contravention of the Act, the authorities register an offense against the accused.

Legal Proceedings [Section 36 A]:[32]



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The legal proceedings involve the prosecution presenting evidence, including the results of chemical analysis, and the defence presenting its case. The court evaluates the evidence and arguments before rendering a verdict.

Offences and Penalties

Punishment for illegal import into India, export from India or transshipment of narcotic drugs and psychotropic substances

Sl. No	Offences	Penalties
1.	Contravention involves small quantity	Imprisonment may extend to one year or fine more than 10,000 or both.
2.	Contravention involves quantity lesser than commercial quantity but greater than small quantity	Imprisonment may extend to ten years, and with fine which may extend to one lakh rupees
3.	Contravention involves commercial quantity	Imprisonment shall not be less than ten years but which may extend to twenty years, and shall also be liable to fine which shall not be less than one lakh rupees but which may extend to two lakh rupees

Decision of the Honourable Court

After considering the arguments and evidence, the Hon'ble Justice bail to the petitioner with certain stringent conditions. These conditions included executing a self-bond of Rs. 5,00,000, surrendering the passport, attending trial hearings, refraining from any criminal activities, and not influencing or threatening prosecution witnesses.

SUMMARY

In the case of Arun V vs. state by inspector of customs, Arun V faced accusations of attempting to export 'Non-Woven Shopping Bags' to Malaysia, with white powder suspected to be Methaqualone found in the bag handles during customs examination. The dispute centred on the accuracy and validity of the chemical examination report, the absence of qualitative or quantitative analysis on the samples, allegations of sample tampering, and Arun V's claim of not being the actual owner or exporter of the goods. The Customs Department, representing the respondent, argued that the chemical report indicated the presence of 'Ketamine' and cited Arun V's alleged admission of moral responsibility for the export. Ultimately, the Hon'ble Justice granted bail to Arun V with stringent conditions, emphasizing the importance of forensic analysis, maintaining evidence integrity, and the burden of proof in cases under the NDPS Act. This case underscores the significance of a balanced legal process that ensures justice while safeguarding the rights of the accused.

CONCLUSION

The Narcotic Drugs and Psychotropic Substances Act of 1985 is a key piece of law in India's fight against drug addiction and trafficking. It has evolved over time to reflect altering cultural values and commitments on a global scale. A recent initiative to decriminalize having small amounts of drugs for personal use represents a shift toward a more understanding viewpoint. The Arun V V. State by Inspector of Customs case highlights forensic analysis, the integrity of the evidence, and the rights of the accused while shedding light on the complexity of drug-related legal proceedings under the NDPS Act. The continuous effort in India to control narcotics and psychotropic substances aims to strike a balance between judicial enforcement and humane alternatives.





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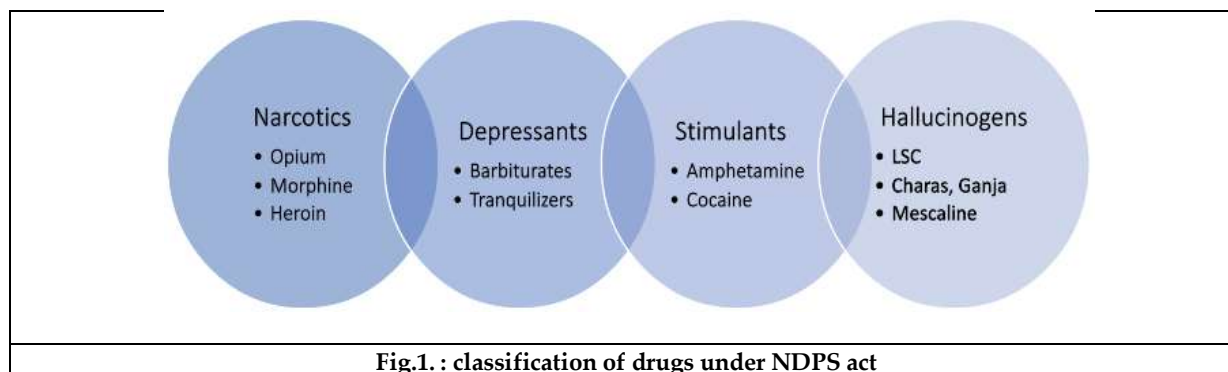


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Table: list of drugs in small and commercial quantity

Drug	Small Quantity	Commercial Quantity
Amphetamine	2 grams	50 grams
Buprenorphine	1 gram	20 grams
Charas/Hashish	Charas/Hashish	1 kg
Cocaine	2 grams	100 grams
Codeine	10 grams	1 kg
Diazepam	20 grams	500 grams
Ganja	1 kg	20 kg
Heroin	5 grams	250 grams
MDMA	0.5 gram	10 grams
Methamphetamine	2 grams	50 grams
Methaqualone	20 grams	500grams
Morphine	5 grams	250 grams
Poppy straw	1 kg	50 kg





RESEARCH ARTICLE

A Prospective Comparative Study on the Outcomes between Metronidazole and Clindamycin Therapy in Patients with Bacterial Vaginosis

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ABSTRACT

Bacterial Vaginosis is a polymicrobial infection which occurs because of alteration in vaginal microbiome and the most common recommended therapy is oral Metronidazole for 7 days or intravaginal Clindamycin pessaries for 3 days. In our study the therapeutic effectiveness and safety of oral Metronidazole (400mg TID for 7 days) and intravaginal Clindamycin pessaries (100mg at bedtime for 3 days) were compared in patients diagnosed with Bacterial Vaginosis. A Prospective observational study was conducted from December 2021 to May 2022 in the Department of Obstetrics and Gynecology, NRI General Hospital, Guntur. A total of 36 female patients with Bacterial Vaginosis were divided into two groups: oral Metronidazole group (N= 17) and intravaginal Clindamycin pessaries group (N= 15) and were followed for one month. This study showed a 100% cure rate in both Tab. Metronidazole and Intravaginal Clindamycin pessaries groups. Therapeutic failure is seen in none of the patients in both the Metronidazole group and the Clindamycin group. The recurrence rate in two groups was observed, two patients (12.5%) had recurrence of Bacterial Vaginosis after one month in the oral Metronidazole group and no patient had a recurrence in the intravaginal Clindamycin pessaries group. More adverse effects were reported in patients of Tab. Metronidazole group than that of patients in the Intravaginal Clindamycin group. Intravaginal Clindamycin pessaries are a more convenient dosing alternative than oral Metronidazole in treating Bacterial Vaginosis.

Keywords: Bacterial Vaginosis, Metronidazole, Clindamycin, Therapeutic efficacy, Safety.





INTRODUCTION

Bacterial Vaginosis (BV) is a common vaginal infection that is associated with the loss of the Lactobacilli colonies with subsequent overgrowth of anaerobic polymicrobial within the vaginal lumen [1]. The vaginal microbiome (VM) mainly lactobacillus plays a critical role in female reproductive health, which can be greatly influenced by antibiotics and hormone therapy. Infections in the vagina appear as a result of a violation of the normal flora of the vagina, which suppresses the immune response of the host and pathogenic microorganisms entering the vagina [2, 3]. The initial and the most common manifestation of BV is vaginal offensive odour. Increased vaginal discharge is typically mild to moderate; vulvar irritation can also be observed but is less common [1]. Clinically, BV is characterized by a vaginal discharge which is thin, homogenous and having vaginal pH >4.5. When added to 10% Potassium hydroxide solution, the discharge gives fishy- amine odor and under microscopic evaluation, it contains clue cells. The etiology of BV is unknown, although current evidence suggests that it is a polymicrobial infection involving *Gardnerella vaginalis*, anaerobic bacteria involving *bacteroid* species, *mobiluncus* species, *Mycoplasma hominis* and anaerobic cocci [4]. Predisposing factors for BV include: Recent use of antibiotics, a decreased production of estrogen by the host, wearing an intrauterine device (IUD), vaginal douching by the use of scented soaps or perfumed bubble bath and antiseptics during the bath, sexual activity, smoking, use of contraceptives (e.g., spermicides). This may increase the likelihood for the development of infection. Women's awareness of BV is low and often they self-medicate with antifungals before presenting very late when symptoms have become intolerable. More than one-half of all women with BV have no symptoms [5].

Untreated BV may lead to increased risk of sexually transmitted diseases (STDs) including HIV (Human Immunodeficiency Virus), Chlamydia, Gonorrhea etc., by two-fold than normal. BV predicts Human Papilloma Virus (HPV) persistence, implying that treating even asymptomatic BV in women with HPV co-infection must be warranted. During pregnancy, BV is associated with an increased risk of spontaneous abortion and preterm delivery. It also increases the risk of chorioamnionitis, premature rupture of membranes, and postpartum endometritis in the case of pregnant women [6]. Recommended therapy for BV was oral Metronidazole (MTZ) for 7 days or intravaginal Clindamycin (CLN) pessaries for 3 days for maximal effectiveness. Recurrence of disease is the most common problem. Many studies were conducted on the treatment of BV by comparing the oral and intravaginal formulations of MTZ and CLN. In this study, the efficacy and safety were compared between oral MTZ and intravaginal CLN [7, 8].

MATERIALS AND METHODS

Study Design

This is a prospective observational study, which assessed the efficacy and safety outcomes of Metronidazole and Clindamycin therapy in patients with BV satisfying Amsel's criteria in the Obstetrics and Gynaecology (OB/GYN) department of NRI General Hospital, Mangalagiri, Guntur.

Study Duration

This study was conducted over for 6 months from December 2021 to May 2022.

Study population

Patients aged 18-50 years who were diagnosed with BV in the department of OB/GYN were included by considering out the following inclusion and exclusion criteria.

Inclusion Criteria

All the female patients of age group between 18-50 years who were diagnosed with BV and prescribed with oral Metronidazole and intra vaginal Clindamycin pessaries in the department of OB/GYN in NRI General Hospital, Mangalagiri, Guntur.



**Sindhu Vaishnavi Valicherla et al.,****Exclusion Criteria**

Female patients with vaginal discharge which do not satisfy Amsel's Criteria for confirming BV may be due to other vaginal infections. Patients who were on long term steroids or immune suppressants, who received antibiotics for any associated conditions in the week before the vaginal culture was taken. Patients who are known allergic to either Metronidazole or Clindamycin and patients who are not having informed consent.

Study Procedure

Patients who visited OB/GYN department with complaints of vaginal discharge are examined and vaginal swabbing was done. Later, the swab was sent for microscopic examination for detecting BV under Amsel's criteria.

For a more accurate diagnosis of BV, among the four domains under Amsel's criteria, any three positive results is made mandatory which includes:

1. Demonstration of clue cells
2. A pH greater than 4.5 indicates infection
3. Characteristic thin, gray, and homogeneous vaginal discharge
4. Whiff test

The demographic details (name, age, sex and other required information) and clinical data of patients including chief complaints, past medical and medication history, confirmatory diagnosis and other relevant details were collected by reviewing their case sheets and the information was noted in a patient data collection form. Medication reconciliation was made by interviewing the patient to identify whether they are using antibiotics or steroids before the examination of vaginal discharge. If the patient is using antibiotics or steroids their dose, route of administration, frequency and duration of therapy were also noted. A personal visit was made to all the patients who were included in the study to collect any further information. The study population was divided into two groups and was monitored for efficacy and safety parameters after the successful completion of the antibiotic treatment course. Group A received oral Metronidazole 400mg TID for 7days and Group B received intravaginal Clindamycin pessaries 100mg OD for 3days. For all the patients medications were cross-checked with their treatment chart.

End Points

As per the current therapeutic guidelines of FDA, the primary efficacy end point was the therapeutic cure. The therapy targets for two clinical parameters for assessing the endpoints. The initial clinical criteria were therapeutic cure (Resolution of any three of the four domains under Amsel's criteria on the 7th day, after the successful course completion with selective antibiotic therapy) on the 7th day of the visit after the full course with antibiotic, i.e., the disappearance of symptoms and other safety parameters, recording the intensity of any vaginal discharge (severe, moderate, absent) and the existence of unpleasant odor (yes or no). The second clinical criterion was Clinical cure (Treatment success rate and Recurrence rate in the study population within 1-2 months, even after successful course completion of antibiotic therapy) and is defined as normalization of any three of the four domains under Amsel's criteria, i.e., a composite clinical and bacteriological cure at 30th - day visit. Apart from this, Treatment Failure is considered when there is positive for at least three of the four domains under Amsel's criteria in the study population at 7th day, after the successful course completion with selective antibiotic therapy.

Data Analysis

All the data were subjected for analysis to assess the Efficacy and Safety of antibiotics used for treating BV. The data were analysed and the percentage of efficacy was assessed for both the groups. The treatment failures and recurrence rates for the groups of antibiotics were also determined. The rationality of antibiotic prescription was assessed with respective parameters such as indication, dose, frequency, route of administration and duration of therapy. Both the study groups receiving antibiotics were rationally prescribed as per standard texts, relevant literature and guidelines available for treating BV. The prescriptions of all enrolled patients in both the groups were verified for appropriateness and were properly counselled regarding the drug usage and revisit information, and the population groups were also assessed for safety parameters during the antibiotic therapy.



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Statistical Analysis

Average/Means, standard deviation and percentages from the relevant data of the study population were obtained using Microsoft Excel and Graph Pad Prism statistical software.

RESULTS AND DISCUSSION

The data in (Table 1) shows that, 36 patients with complaints of vaginal discharge and offensive odour were confirmed positive for BV using standard Amsel's criteria. All the patients in this study were positive for all four domains of Amsel's criteria. Among these 36 patients, 19 patients were from oral MTZ group, 17 patients were from the intravaginal CLN group and 2 patients from each group were lost to follow-up. The total evaluated patient population in oral MTZ group and intravaginal CLN group were 17 and 15 patients respectively.

Clinical Cure and Therapeutic Assessment

The patients who continued the study were assessed for therapeutic outcomes i.e., therapeutic cure, clinical cure or therapeutic failure after the treatment, using the standard Amsel's criteria, i.e. the results of 4 domains of Amsel's Criteria. According to (Table 2), of the 32 patients, 3 patients of the study population had vaginal discharge persistently even after the course of antibiotic therapy. Of these 3 patients, 2 patients (11.76%) from oral MTZ group and 1 patient (6.67%) from intravaginal CLN group had persistent vaginal discharge even after complete course of therapy which was following the results of a study conducted by Zahra Abbaspoor *et al.*, where 16.7% of Metronidazole group & 13.26% of CLN group had persistent vaginal discharge after one week of therapy [9]. The data in (Table 3) shows, there was no significant difference for positive Whiff tests in both the groups at baseline and after their specific treatments. Of the 32 patients, 2 patients of the study population showed positive to the Whiff test after treatment. Among those 2 patients, 1 patient (5.88%) was from Tab MTZ group and 1 patient (6.67%) was from intravaginal CLN group which was in accordance to the results of a study conducted by Zahra Abbaspoor *et al.*, 9.1% from MTZ group and 7.32% from CLN group showed positive for Whiff test [9]. As per (Table 4), out of 32 patients, 2 patients (11.76%) of the study population from oral MTZ group and no patients (0%) from intravaginal CLN group had pH > 4.5, after a complete course of therapy which was following with the results of a study conducted by Zahra Abbaspoor *et al.*, were 21.2% from MTZ group and 12.26% from CLN group had pH > 4.5. The study population with intravaginal CLN had the maximum effect in normalizing the vaginal pH [9]. The data in (Table 5) explains, of the 32 patients, 1 patient (5.88%) showed presence of clue cells which was from Oral MTZ group even after a complete course of therapy which was compared with the results conducted by Zahra Abbaspoor *et al.*, where 7.32% from MTZ group and 6.82% of patients from CLN group showed the presence of clue cells [9].

Efficacy Assessment

The results obtained from the overall assessment of efficacy parameters in both Tab. Metronidazole group and intravaginal Clindamycin pessaries group were as follows: There was 100% therapeutic cure rate in both oral Metronidazole and intravaginal Clindamycin pessaries groups as shown in (Table 6). These findings coincide with the results of the study conducted by Fischbach *et al.*, where the improvement rate or cure after therapy in Clindamycin group was 83% whereas in Metronidazole group was 78%. Therapeutic failure is seen in none of the patients in both Metronidazole group and Clindamycin group [10]. Of the 32 patients, 2 patients (12.5%) had shown the recurrence of BV after one month in oral MTZ group whereas no recurrence was reported in intravaginal Clindamycin pessaries group. These results can be compared with the results from the study conducted by Arredondo *et al.*, where there was 7% in Metronidazole group and no recurrence was observed in the Clindamycin group [11].

Safety Assessment

A total of 18 Adverse Drug Reactions (ADRs) were reported in the study population. Of these, 17 ADRs (82.35%) were reported in 14 patients from oral MTZ group whereas only 01 ADR (05.56%) was reported in the intravaginal CLN group (Figure 1).

1. Of the 17 patients with oral MTZ group, 14 patients developed 17 ADR's





2. Of the 15 patients with intravaginal CLN group, only one patient developed ADR. According to (Table 7), in oral Metronidazole group, out of 17 patients, 14 patients developed ADRs such as Nausea, Metallic taste, discoloured urine and Constipation where as in the intravaginal Clindamycin pessaries group out of 15 patients, only 1 patient developed discomfort and vulvovaginal irritation while using pessaries. One patient from oral MTZ group developed 3 ADRs (Nausea, Metallic taste and Discoloured Urine). Among all the ADRs reported in Tab. Metronidazole group, Nausea was seen in 10 patients (50%), Metallic taste in 5 patients (35.71%), Discoloured urine in one patient (7.14%) and Constipation were reported in one patient (7.14%). These findings were following with Jack Sobel *et al.*, where 72.86% of patients experienced ADRs due to the MTZ group [9].

Assessment of ADRs

To the reported ADRs, Causality, Severity, Predictability and Preventability were measured. All the ADR's that were reported are Mild, Predictable and non-preventable. In causality assessment, we found that the adverse effects such as Nausea, Metallic taste and discoloured urine were probable. Constipation, discomfort and vulvovaginal irritation were the possible side effects according to Naranjo's causality scale and Karch and Lasagna scale.

CONCLUSION

This study demonstrates that both the treatments (oral 7-day Metronidazole and intravaginal 3-day Clindamycin) were equally effective in curing the disease but intravaginal Clindamycin pessaries showed no recurrence and fewer adverse effects. On the other hand, oral Metronidazole therapy had more systemic side effects and two cases of recurrence. Therefore, intravaginal Clindamycin pessaries are a more convenient dosing alternative to oral Metronidazole in treating Bacterial Vaginosis.

Abbreviations

MTZ- Metronidazole.

CLN- Clindamycin.

BV- Bacterial Vaginosis.

OB/GYN- Obstetrics and Gynaecology.

IUD- Intra-Uterine Device.

STD - Sexually Transmitted Diseases.

HPV- Human Papilloma Virus.

HIV- Human Immunodeficiency Virus.

ADRs - Adverse Drug Reactions.

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Conflicts of Interest

The authors report no conflicts of interest in this work.

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Ethical Approval

This study was approved by Institutional Human Ethical Committee of Chebrolu Hanumaiah Institute of Pharmaceutical Sciences, Guntur. (Ref.No. IEC/02/2021)





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Table 1: Socio Demographic Details of the Study Population

Socio Demographic Characteristics	No. of Patients (N=36)	Frequency (%)
Age groups (years)		
18- 25	13	36.11%
26- 30	5	13.88%
31- 35	3	8.33%
36- 40	8	22.22%
41- 45	3	8.33%
46- 50	4	11.11%
Educational status		
Basic	27	75%
Secondary	9	25%
Marital status		
Married	36	100%
Single	0	-

Table 2: Results of Homogenous Vaginal Discharge in Study Population

Groups	Baseline		After Treatment	
Homogenous vaginal	Tab. Metronidazole group (N= 17)	Intravaginal Clindamycin	Tab. Metronidazole group (N= 17)	Intravaginal Clindamycin pessaries





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discharge			pessaries group (N =15)				group (N =15)	
	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%
Present	17	100	15	100	2	11.76	1	6.67
Absent	0	0	0	0	15	88.24	14	93.33
Total	17	100	15	100	17	100	15	100

Table 3: Results of Whiff Test in Study Population

Groups	Baseline				After Treatment			
Whiff test	Tab. Metronidazole group (N=17)		Intravaginal Clindamycin pessaries group (N =15)		Tab. Metronidazole group (N=17)		Intravaginal Clindamycin pessaries group(N =15)	
	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%
Positive	17	100	15	100	1	5.88	1	6.67
Negative	0	0	0	0	16	94.12	14	93.33
Total	17	100	15	100	17	100	15	100

Table 4: Results of Changes in Vaginal pH in Study Population

Groups	Baseline				After Treatment			
Vaginal pH	Tab. Metronidazole group (N=17)		Intravaginal Clindamycin pessaries group (N= 15)		Tab. Metronidazole group (N=17)		Intravaginal Clindamycin group (N=15)	
	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%
>4.5	17	100	15	100	2	11.76	0	0
<4.5	0	0	0	0	15	88.24	15	100
Total	17	100	15	100	17	100	15	100

Table 5: Results of Alterations in the Presence of Clue Cells in Study Population

Groups	Baseline				After Treatment			
Clue cells	Tab. Metronidazole group(N=17)		Intravaginal Clindamycin pessaries group (N=15)		Tab. Metronidazole group (N=17)		Intravaginal Clindamycin pessaries group (N=15)	
	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%
Present	17	100	15	100	1	5.88	0	0
Absent	0	0	0	0	16	94.12	15	100
Total	17	100	15	100	17	100	15	100

Table 6:Efficacy Rates in Both Metronidazole and Clindamycin Groups

Contents	Tab. Metronidazole Group (N=17)		Intravaginal Clindamycin pessaries group (N=15)	
	No. of Patients	%	No. of Patients	%
Therapeutic cure	17	100%	17	100%
Therapeutic failure	0	-	0	-
Recurrence	2	12.5%	2	0





Sindhu Vaishnavi Valicherla et al.,

Table 7: ADRs Reported in Both the Groups

Contents		No. of ADR's*	Percentage
Tab. Metronidazole group (N=17)	Nausea	10	50%
	Metallic taste	5	35.71%
	Discolored urine	1	7.14%
	Constipation	1	7.14%
Intravaginal Clindamycin pessaries group(N=15)	Discomfort and irritation	1	6.67%

*ADRs- Adverse Drug Reactions

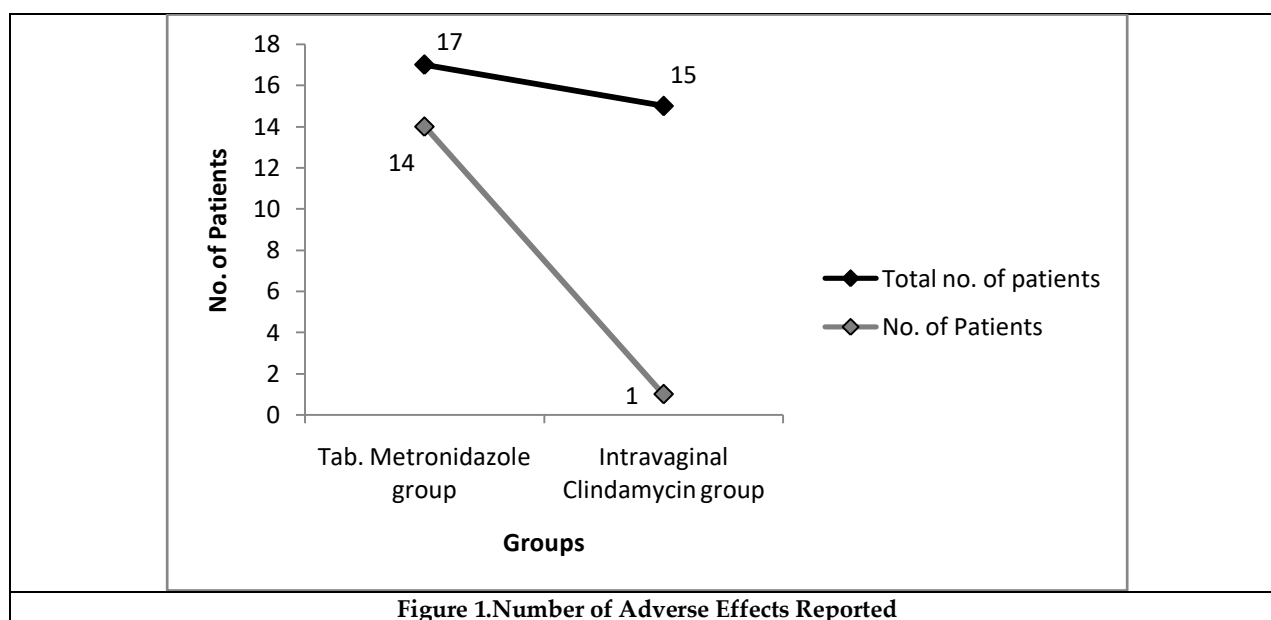


Figure 1.Number of Adverse Effects Reported





Ecological Foundations of the Dimasa Belief System in Assam, India

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ABSTRACT

The objective of this paper is to examine the belief system of the Dimasas, specifically emphasizing the significance of traditional practices related to their ecological foundations. The tribes have established a deep affinity for forests throughout several centuries, with their entire way of life intricately connected to the nature and resources of these forest areas. Their continuous efforts are focused on preserving their natural resources through the establishment of their own traditional and conservative system. The Dimasa tribe is a prominent ethnic group in the Dima Hasao District of Assam, India. Their deep affection and reverence for their natural environment are notably distinctive and unusual. This tribe, similar to other tribal communities, holds peculiar beliefs and practices around some plants and animal species, which they deem as forbidden. On the other hand, they firmly advocate for the importance of protecting sacred groves in order to guarantee the survival and protection of rare, endangered, delicate, and distinct species that reside in these regions. They have acquired the ability to responsibly and efficiently utilize their natural resources without excessive exploitation. This has led to the development of belief systems that consistently guide their social, cultural, and religious elements of life in a sustainable manner. This paper used field observations and qualitative research techniques, specifically employing the historical method of interpretation. This paper concludes their belief system is deeply connected to the preservation of the ecosystem, encompassing various animistic expressions and their interconnectedness. Nature is an integral part of the Dimasa belief system. The natural world serves as the foundation for their religious beliefs, practices, and cultural traditions.

Keywords: Belief System, Biodiversity, Ecosystem, Mythology, Sacred Groves





INTRODUCTION

Indigenous peoples have been forest lovers for thousands of years, and their way of life is woven around forest ecology and forest resources. They are constantly striving to conserve their natural resources by establishing their own traditional, conservative system. The Dimasa tribe, for example, is one of the predominant ethnic groups in the Dima Hasao district of Assam and their love and respect for their natural surroundings are particularly unique and peculiar. The ecological basis of the tribe's belief systems has been studied in the context of sacred groves, with a specific focus on India and Assam. (Hughes and Chandran 1998, Chandran and Hughes 2000, Tripathi 2005, Bhagwat and Rutte 2006, Saikia 2006, Teron 2008, Medhi and Borthakur 2003, Poreku 2014, Bhattacharjee 2015, Gogoi 2020, Shilpa *et al.* 2020, Sanga and Haulle 2022). Sacred groves have been discovered in various corners of the globe, spanning diverse terrains such as mountains, rivers, oceans, and savannahs (Hughes and Chandran 1998, Chandran and Hughes 2000, Bhagwat and Rutte 2006, Chandra 2011, Poreku 2014). India has the highest number of recorded sacred groves compared to any other country on the globe. According to Malhotra *et al.* (2001), it has been reported that 19 out of the 28 states in the country are home to sacred groves. There are an estimated 100,000 to 150,000 sacred groves in India, although not all of them are large enough to have a significant impact on biodiversity conservation (Bhagwat *et al.* 2005, Poreku 2014). It is true that sacred groves are known for offering a range of services, such as spiritual, medicinal, material, and ecological functions that can aid in the restoration of degraded lands (Chatry 2001, Khan *et al.* 2008, Poreku 2014). They play a vital role in biodiversity of the region. Their shading effect helps prevent erosion and creates a favorable environment for various organisms involved in nutrient cycling, ultimately leading to improved soil fertility (Tiwari *et al.* 1998, Poreku 2014).

The Dimasa tribe, like any other tribal tribe, believes in and maintains strange relationships with some plants and animal species that they consider taboo. They, on the other hand, have a long-held belief in the need to preserve sacred groves in order to protect and conserve rare, endangered, vulnerable, and endemic species found in sacred groves. They have learned to manage and use their natural resources sensibly and economically by not over-exploiting them, and in doing so, they have developed a sense of belief systems that have always directed their social, cultural, and religious aspects of life in a sustainable manner (Barpujari 1997, Danda 1978, Bordoloi 1984, Chatry 2001, Roy 2002, Bojhom 2012, Bathari 2011, Marak 2012, Bojhom 2012, Medhi and Borthakur 2013, Thaosen, 2015, Daulagajau 2015, Gogoi 2020, Borah and Sarma, 2022, Gogoi 2023, Dhanaraju 2023). The Dimasa Kacharis, along with other Kachari groups like the Bodo-Kacharis, Koches, Rabhas, Lalungs, Tipperas, and more, all share a common identity as a major group in northeast India (Danda 1978, Bordoloi *et al.* 1987, Longmailai, 2017). However, The Dimasas or Dimasa Kacharies are the predominant ethnic group in the N. C. Hills district of Assam. The Dimasa Kacharis have a rich history as an indigenous community. Assam currently is inhabited by a diverse range of Kachari tribes, such as the Bodo-Kacharis, who can be found in districts like Kamrup, Barpeta, Dhubri, Goalpara, Darrang, and Sonitpur. In Upper Assam districts, one can find the Sonowal Kacharis and Thengal Kacharis. The Barmans live in the Cachar district, while the Mech Kacharis are dispersed in small clusters throughout the plain's districts. The Dimasa Kacharis are located in the Autonomous Hill Districts, specifically Dima Hasao (formerly North Cachar) Hills and Karbi Anglong Districts. Dimasas are currently located mainly in the Dima Hasao Hills District. However, small, scattered clusters can still be found in Dhansiri, Mahangdijua (Manja), Hawaipur, and some remote areas of the Karbi Anglong District. The Dimasas are known as "Barmans" in the District of Cachar (Daulagajau 2015). As per B.N Bordoloi's (1987) understanding, it was found that the people of this particular sections are classified as part of the "Great-Bodo race" based on their racial characteristics. From a linguistic standpoint, they are classified as part of the Tibeto-Burman group. The majority of them engage in shifting (*jhuming*) cultivation, however a few have turned to settled cultivation in the limited flat areas of the hill district, such as the Mahur valley at Mailing (Borah and Sarma 2022). Irrespective of whether they engage in *jhuming* or establish agriculture, their villages are permanent. The term 'Dimasa' has a literal translation that refers to someone being the offspring of a significant River. The word 'Di' signifies water, 'Ma' represents big, and 'Sa' denotes son. Given the Brahmaputra's status as the largest and longest river in Assam, it is possible to speculate that the Dimasas saw themselves as the



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descendants of this enormous river. (Barpujari 1997, Medhi and Borthakur 2013). Dimasa's migration to the present region of N.C Hills remains a subject of debate due to lack of documentary evidence. The region was governed by a series of Kachari monarchs from approximately 1000 A.D until the 18th century. Prior to 1832, the Dima Hasao area was encompassed within the territorial boundaries of the Kachari Kingdom. The Kachari kingdom extended from the southern foothills of the Lushai mountains to the northern Jamuna River, and from the eastern Katcha Naga and Angami Hills to the western Kopili river. Dima Hasao was designated as one of the capitals by the Kachari monarchs. In 1830, the Dimasa king, Gobinda Chandra, was assassinated by his general, Gambhir Singh. The British government seized control of the southern region of the country on August 14, 1832. Tularam, the Dimasa General, then governed the remaining region. In 1837, the British captured additional territory of this country. Following Tularam's demise in 1854, the British Government assumed responsibility over the remaining portion of the Kingdom, incorporating it into the Asalu sub-division. In 1867, the subdivision of Asalu was eliminated and its territory was divided and sent to the districts of Nagaon, Cachar, Jaintia Hills, and Khasi. The Dima Hasao district was formerly a part of the Cachar district. In 1880, a subdivision was established with its headquarters situated in Gunjung. In 1895, the headquarters were relocated from Gunjung to Haflong. A new civic district, named 'United district of North Cachar and Mikir Hills', was established on November 17th, 1951. Subsequently, two councils, namely the N.C Hills district council and Mikir Hills District Council, were established in accordance with the provisions of the 6th schedule of the constitution. The Dima Hasao District Council was established on April 19, 1952. Prior to 1961, the Dimasa were regarded as a sub-tribe of the Kachari. However, they are now recognized as an "separate community"

MATERIALS AND METHODS

It is important to mention about their brief history here because the Dimasas residing in the Dima Hasao district (formerly known as N.C Hills district) is officially recognized as "Hill Tribes" in Assam under the Scheduled Castes and Scheduled Tribes (Amendment) Act of 1976. The Dimasas residing in other regions are classified as "plain tribes". The present study mainly focuses on the Dima Hasao District of Assam. The total geographical area of the district is 4,890 sq.km with a total population of 2,13,529 (as per Census 2011). This Hill district of Assam is rich in forest resources, flora, and fauna, minerals with fertile land for agriculture, and horticulture, etc. The population of the district is predominantly tribes. The Major tribal ethnic group of this district is Dimasa, Jemi Naga, Hmar, Kuki, Biate, Hranghal, Khelma, Jaintia, Karbi, Vaiphei etc.. Besides these large numbers of non-tribals are also living there. However, this study is an attempt to look into the ecological foundation of the belief system of the Dimasas in Dima Hasao district of Assam. This study is based on primary data collected from archival sources and field observations regarding the belief system associated with the sacred places in the district. In addition to this collecting data strategy, other documentation tools such as video and audio recording have been employed during oral interviews from the priests and elderly persons. The secondary materials were obtained from several pertinent Government publications, such as the Annual Souvenirs of Dima Hasao Autonomous Council, reports, websites of Assam State, e-journal articles, and books. Given the specific focus of this study on the mythology of the sacred groves and the overall belief system of the Dimasa tribe, the samples were purposefully collected exclusively from this community. This study used field observations and employed qualitative research approaches, mostly relying on the historical method (interpretation technique), to examine the significance of the belief system linked to the ecological foundation of the community.

RESULTS AND DISCUSSION**Mythological Origin of Sacred Groves**

The Dimasas adhere to a system of dual descent, wherein genealogy is traced from both parents concurrently and each individual trace their paternal ancestry to one of the forty male clans known as "sengphong" or "holder of the sword," and their maternal ancestry to one of the forty-two female clans referred to as "jalik" or "julu" (Danda 1978, Bordoloi 1984, Bathari 2011, Marak 2012, Thaosen 2015, Thaosen 2017, Gogoi 2020). The clans are dispersed





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throughout twelve designated areas known as daikhos, which are considered sacred groves. The majority of researchers provide that the word "Daikho" is a combination of two Dimasa words, "Madai" which signifies 'God', and "kho" which denotes 'place' or 'habitation'. Consequently, "Daikho" can be interpreted as 'the place or abode of the gods' of the Dimasas. Thaosen (2015), a local Dimasa scholar, has highlighted the mythological genesis of the Dimasa community. She stated that the Dimasas have a unique social structure marked by dual descent, where each individual is granted membership in two clans - one inherited from the father and the other from the mother. There is a total of eighty-two clans, with forty being male clans named *sengphong*, and forty-two being female clans called *jilikorjulu*. Each male and female clan possesses their own ancestral deities, who are appeased by their own clans.

One of the significant myths of the Dimasa tribe elucidates the genesis of the cosmos and the positioning of their ancestors. According to this myth, the Dimasas have a belief in a mythical tale regarding the beginning of life on Earth. According to this myth, a divine bird named "Arikhidima" was formed through her union with Bangla Raja and then deposited seven eggs. Out of these eggs, six hatched, giving rise to Sibarai, Alu Raja, Naikhu Raja, Waa Raja, GunyungBraiyung, and Hamiadao. However, the seventh egg remained unhatched until Hamiadao, the sixth son, forcefully cracked it open, unleashing a multitude of malevolent spirits believed to be the cause of society's troubles. The Dimasas have the belief that these six benevolent ancestral deities govern all the territories inhabited by their community. Consequently, it is believed that these ancient deities reside in a collective of twelve similar places (Sacred Places).

According to their belief system, there was a deity known as Bangla Raja, who was considered the "god of earthquakes", and he resided in a location named Damra, which was regarded as the heavenly realm in the Dimasa culture. Arikhidima, who experienced a miraculous pregnancy, encountered a significant challenge in locating an appropriate location to deposit her eggs. An eagle of the golden variety was dispatched to locate a specific location at the point where the Dilao and Sangi Rivers meet. Arikhidima laid seven eggs, from which she successfully hatched six benevolent gods named Shibarai, Alu Raja, Naikhu Raja, Waa Raja, Gunyung-Braiung, and Hamiadao, together known as madai. The seventh egg, which remained intact when shattered, gave rise to deformed malevolent entities that caused extensive disorder. The Dimasas believe that they are the direct descendants of the six gods. Also, they believe that the malevolent spirits that emerged from the seventh egg reside in the hills and rivers. These spirits are believed to be responsible for causing diseases and calamities. Therefore, they are worshipped during the cultivation period or when someone falls ill or experiences misfortune (Danda 1978).

Sacred Groves and its attributions

The ancestral clan-gods or deities are thought to hold authority over the entire Dimasa land, giving rise to the concept of a "territorial-god". These areas are usually known as "sacred groves" because they include plants that have both religious and medical properties. (Medhi and Borthakur 2013). In that particular belief system of the Dimasas, there exist 12 sacred groves in the present region of N.C Hills. Scholars hold divergent viewpoints regarding Daikhos. Scholars attribute several meanings to these sacred groves, known as Daikhos. Despite this, in his most recent paper, Sarma (2022) has provided a precise description of these twelve Daikhos which are spread in different places in the N.C Hills. But the "etymologies" of Daikhos have not been correlated with those of the other researchers.

Aludaikho: Aludaikho is found in two places; one at Mahurbra village near Dihangi at the confluence of river Mahur and Diyung and the other one at Wajaw village of Maibang area. The existence of two comparable Daikhos in separate regions of the same district may be attributed to the need to accommodate the worship of clan gods by the local population in a convenient manner. The deity that serves as the guardian of this particular Daikho is Alurajai, and the priest's lineage is known as Daulagupu.

Longmaila daikho: It is located at Moti village of the Mahur area. The sacred grove Lungmailam Daikho of Dijua Haphai is called in honor of the divine son of the deity Du Raja and the goddess Dilaoju. Lungmailam, the son of Du Raja and Dilaoju, was assigned the task of overseeing the Dijua Haphai, as revealed in the oral tradition. The territory



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of Dijuahaphai was already under the dominion of the Goddesses Baminju. While on a quest to find the Dijuahaphai, the Lungmailam Raja saw the Goddesses and thereafter entered into matrimony with one of them, as instructed by his father. The Lungmailam Raja's clan is said to belong to the Hakthangsa male clan, while the Goddesses Baminju was from the Tharaju female clan. Based on the aforementioned historical account, the Dimasas of Dijuahaphai in Karbi Anglong region worshipped the deities Lungmailam and Baminju as their local gods and goddesses. Subsequently, the Hakthangsa male clan and tharaju female clan have been granted the highest jurisdiction to serve the deities in this consecrated forest as Lungmailamdaikho.

Longmailumdaikho: The site is situated in the village of Dijowahapa in the Mahur region. Hasnu and Nabensa are the clans of the Jonthaima and Barwa of this Daikho respectively.

Manjadaikho: The Mailu site is situated in the Langting region. The deity who serves as the guardian of this Daikho is Gunyung Braiyung, and the religious leaders of the community are from the Thaosen and Ardao clans.

Damadidikho/Riaodaikho: Abungbra is located in close proximity to the confluence of the Hagong and Diyung rivers, positioned between the settlements of Sampharidisa and Gaijon/NogdiDaulagupu. It is the largest among the 12 Daikhos. The Daikho is a place of devotion where the five clan gods, namely Naikuraja, Nobaraia, Waraja, Shivarai, and Kampadi, are revered. The priest's clan is Phonglosa.

Hamridaikh: The site is situated in the Palaipa/Daudungkhor village inside the Thaijuwari area, where the streams Langting and Diyung meet. The priest of this Daikho belongs to the Thaosen clan.

Misimdaikho: This site is situated in the Gerembasti village inside the Mahur region. The deity worshipped in this Daikho is Misimraja, and the priest belongs to the Nabensa clan.

Baiglaidaikho/Baigiadikho: The site is situated in the secluded settlement of Bongkhai inside the Khepre region. The priest of this Daikho belongs to the Langthasa clan.

Waibradaikho: The settlement of Hajageder in the Langting area is recognized as the most pristine Daikho among all the Daikhos of the Dimasas. This Daikho has only recently been rediscovered by the community after a prolonged period of obscurity. The priest of this Daikho belongs to the Diphusa clan.

Mongrangdaikho/ Semkhordaikho: This site is situated in the Semkhor village, the Daikho of the Semsas is regarded as the authentic one. The deity worshipped in this Daikho is Mongrang, and the priest belongs to the Phonglosa clan.

Mongrangdaikho: This site is situated in the vicinity of DelenBathari, near the villages of Banjikhalu or NatunDisao in the Maibang area, is a place known as Dugubra. It is located at the confluence of the rivers Dugu and Delen. There exists a narrative concerning this individual named Daikho. Initially, it was the Daikho of the Semsas of Semkhor. Out of fury, the priest once hurled the god, resulting in the god losing one of its hands. The son-in-law of the priest, who belonged to the Bathari religious group, discovered the deity lying on the path leading to his in-law's residence. He retrieved the deity and established the Daikho at DelenBathari. The Semsas from Semkhor village also participate in the annual worship of this Daikho. The Semsas residing outside the Semkhorvillage venerate their own ancestral deity in this particular place called Daikho. Due to restrictions, Semsas residing outside Semkhor village are prohibited from participating in the worship ceremonies held at the Daikho in Semkhor village. The priest of this Daikho belongs to the Bathari clan.

Ronchandidaikho (Bamin): Under the rule of the Kachari dynasty, the original location of this Daikho was in Dajdi village, situated by the Dhansiri River. However, when the seat of the Kachari Kingdom was relocated to Khaspur (now in the Cachar District of Assam), a new Daikho was established there. Currently, just the monuments remain





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at Khaspur, devoid of any Dimasa priest, and all the customary rituals are conducted at the Daikho situated in Dajdi hamlet. The priest of this Daikho belongs to the Thaosen clan.

Ecological Significance of Belief System

In her blog, Bojhom (2012) explores the theme of "Daikhoism," which refers to the native religion of the Dimasas. Each Daikho is presided by a regulating *madaï* and has a specific territorial jurisdiction and a unique group of followers known as *khel*. This *Khel* transcends various clans of the Dimasas, namely the *shengphong* clan which consists of males. The presiding deity is adored by many clans based on their respective *khel* affiliations. In Dimasa society, those who are members of the same *shengphong* or the same *jaadi/jilik* (female clan) are prohibited from marrying each other. Moreover, people who worship the same presiding deity, known as people belonging to the same *khel*, are also forbidden from marrying each other. Mongrang is a prominent deity in the Mongrang Daikho, and individuals from the Mongrang *khel*, who are followers of Mongrang, may be found in both the Bathari and Phonglo clans. Therefore, even if two individuals belong to distinct *shengphongs*, they are prohibited from marrying each other if they worship the same *madaï* and belong to the same *khel*. In a Daikho, in addition to the presiding *madaï*, several non-presiding *madaïs* (deities) might also be worshipped. Throughout Dimasa society, a well-defined administrative hierarchy has been in place, spanning from the most esteemed priests to the ordinary individuals belonging to various clans. Every one of the 12 Daikhoes has a dedicated priest or Jonthai who is responsible for conducting and overseeing the religious ceremonies associated with the Daikho. With an unwavering authority, a Jonthai diligently carries out his responsibilities under the guidance of a head priest or Jonthaima of all the Daikhoes. At the pinnacle of the hierarchy, we find the principal priest or chief priest, known as 'Gisia'.

It is worth noting that this esteemed position can only be held by a member of the Jidung clan. The people chosen for Jonthaiship is designated by the Gisia, in consultation with the priests of the respective Daikho, through the ceremonial act of sprinkling holy water or Dithar. Once a year, the Dimasas engage in the worship of their ancestor deities by performing a rite known as *madaï-khilibmba*. This practice is implemented to ensure the overall well-being of the family. Gerba is a ritual that is performed for the well-being of the family, whereas Raji-ni-Gerba is a ritual that is performed for the well-being of the entire community. Misengba is a ceremonial practice observed to promote the well-being of the entire community. Various researchers and sources from the Dimasa community have provided their own compilations of the twelve Daikhoes, which exhibit little discrepancies among them. However, all of these lists share some names of Daikho, among which the Riao Daikho, also known as Damadi Daikho, is considered the most prominent, followed by Aludaikho and Mongrang Daikho. These Daikhos symbolize the lush plant life of a region, often creating a distinct contrast with the surrounding depleted forests. It is clear from the locations of the Daikhoes maintained by the Dimasas that they play a crucial role in conserving soil, protecting water sources, and maintaining downstream water quality. These important ecosystem services are provided by the Daikhoes, which are strategically placed at the catchment areas of major rivers or rivulets, as well as at the point of origin of perennial streams (Medhi and Borthakur 2013). According to historical accounts, the Dimasas hold the belief that deities residing in a specific Daikho are responsible for safeguarding the local population and determining their fate.

The traditional belief system of Dimasas involves direct, personal relationship with the living, the dead and the totality of nature. From the traditional Dimasa perspective, there is no clear demarcation between the sacred and secular realms, the religious and non-religious domains, and the spiritual and material aspects of existence. If any cultural component is disrupted, it has a significant impact on the entire social structure due to the intricate interconnections between these elements. As observed, the term used for them in Dimasa language is *madaï*. The malevolent entities that originate from the seventh egg of Arikhidima are accountable for all ailments and natural disasters. It is necessary to venerate and pacify these spirits in order to mitigate their harmful effects on the afflicted individuals and their families. Prior to establishing a new *jhum* site, it is necessary to correctly worship the malevolent spirits in order to avoid their anger, which can result in unfavorable conditions such as little rainfall and crop infections. Dimasas hold the belief that their environment, consisting of forests (*hagra*), hills, and streams, is inhabited by both malevolent and positive spirits. Consequently, it is necessary to carry out a ritual before to undertaking any adventure, such as getting into a forest, engaging in fishing activities, or clearing a forest. This



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obligatory ceremony entails offering a sacrifice creature to solicit consent from the spirits to proceed with an action without creating any disruption to the spirits present. Also, this serves as a means to seek favors and safeguard oneself. As part of the majority of forest-related rites, it is customary to offer a little bird as a sacrifice in order to placate the deities and spirits of the forest. Dimasas hold the belief that several types of spirits inhabit the forest. Certain entities may intentionally disorient you by shouting out your name, while other malevolent spirits may deceive you by creating a deceptive perception of being the target in hunting endeavors. Also, trees, rivers and streams are also thought to be inhabited by diverse spirits. Dakinsa stands out as a major figure among them. A Dakinsa is a spirit that is thought to lack anthropomorphic characteristics and instead appears as a floating ball of fire in the air. Cultivating the area where the trees are located is likewise forbidden. In order to cultivate the plot of land, it is necessary for a *hojai* (priest) to conduct a sacrificial rite at the location to appease the guardian spirits of the trees before cultivation may take place. Therefore, the traditional Dimasas show reverence towards the trees and flora as they are considered the property of *madai*. This demonstrates that, according to the traditionalists, the trees and plants are not mere inanimate objects, but rather possess life and are considered to be the property of the "Supreme Being". There is a ban on the felling of specific trees and trees that give fruit.

These prohibitions are rigorously adhered to and cannot be violated. The taboos and limits implemented in sacred woodland places have a crucial role in conserving the surrounding ecology. It is often believed that disregarding the regulations can result in unfavorable omens and invoke the malevolent spirits dwelling in the woodlands. In their latest publication, Kikhi and Gogoi (2022) have highlighted the sacred plants that are significant to the Dimasas. The prominent species comprise *khande* (a local term for a tree whose flowers are eaten by bird species like bulbul) and *hamlai phang* (the Indian gooseberry, commonly referred to as *amla*). Individuals who have performed the ceremony of *khandehuma* or *hamlai huma* during their youth are forbidden from cutting down these particular plants. As part of the marriage preparation, a certain individual was tasked with the obligation of down the *khandai* tree to create space for the event. However, he had executed the *khandehuma* ritual, which made him unable to descend from the tree. According to another account, he experienced severe illness during his early years. After consulting with a Dimasa fortune teller, the individual's parents were asked to appease the ghost and perform the *khandehuma* ritual. The parents complied with the suggestions and offered prayers for their son's swift recovery. Upon the conclusion of the ritual, his well-being was fully rejuvenated. Hence, he was later forbidden from felling the identical tree, since it had assumed the role of safeguarding his welfare.

CONCLUSION

The study concludes that the Dimasa group possesses traditional beliefs that are animistic in origin, which have been passed down to them orally by their ancestors. Their belief is closely intertwined with the preservation of the ecosystem, encompassing several animistic manifestations and their interconnections. The Dimasa worship tradition includes the ceremonial sacrifice of a variety of animals and birds, such as pigs, goats, buffaloes, fowls, ducks, and others. As mentioned, this community, like to every other tribal community, holds beliefs in and upholds peculiar associations with certain plants and animal species that they consider as taboo. On the other hand, they strongly believe in the necessity of safeguarding sacred groves to ensure the preservation and conservation of rare, endangered, sensitive, and unique species that inhabit specific places. They have acquired the ability to prudently and efficiently handle their natural resources by avoiding excessive exploitation. In the process, they have cultivated belief systems that consistently guide their social, cultural, and religious aspects of life in a sustainable manner. Therefore, one cannot talk about Dimasa belief system without nature. Nature is source of their belief system. Therefore, considering the above-mentioned results and inquiry, one could argue that conventional approaches to conserving biodiversity, like those used in the management of sacred groves, offer efficient ways of safeguarding natural resources. These methods employ traditional methods rooted in religious and cultural customs, along with taboos. However, environmentalists often overlook the valuable contributions that traditional belief systems have made to biodiversity conservation and land restoration efforts.





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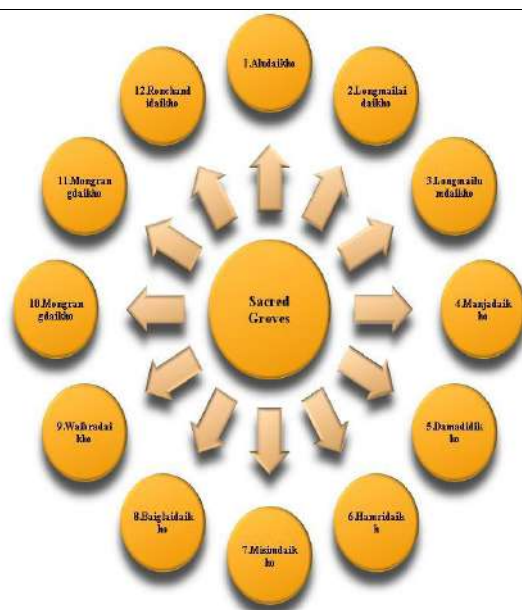


Figure:1 Names of the Sacred Grove





Cosmetic Curation: Examining the Role of Influencer Marketing In Shaping Consumer Perception

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ABSTRACT

The growing influence of social media networks significantly impacts consumers' purchasing decisions. To introduce new products and demonstrate their uses, marketers have developed a notable marketing strategy known as "influencer marketing." The concept behind influencer marketing is to establish a connection between consumers and the brand. The current study aims to identify the various factors that influence consumer perceptions of influencer marketing for cosmetic products. It also seeks to measure the impact of these perceptions on consumer buying behavior. To conduct this research, a purposive sampling method was employed, involving the recruitment of 100 female cosmetic consumers from Generation Z and the Millennial generation. The study has revealed the factors that contribute to consumers' purchasing decisions, particularly when influenced by influencer marketing. Importantly, it has demonstrated that consumer perceptions of influencer marketing for cosmetic products have a positive impact on actual cosmetic product purchases.

Keywords: Influencer marketing, Perception, Purchase decision, Cosmetic Products.

INTRODUCTION

In the realm of daily consumer choices, the intricacies of decision-making unfold as a protracted process known as the purchase decision process [1] (Kotler & Armstrong, 2012). However, the landscape has witnessed a transformative surge over the past decades with the advent of a formidable social force—social media. This digital phenomenon has not merely altered the attributes and expanses of social networks but has also granted users a platform to divulge their identities [3] (Taylor & Strutton, 2016). The escalating allure of social media networks exerts a profound influence on consumers' purchasing decisions, as evidenced by a growing dependence on



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recommendations from their social circles [4] (Liu & McClure, 2021). Studies underscore the magnitude of this shift, revealing that a substantial 74% of consumers significantly rely on social media, exerting a substantial impact on their purchasing behavior [5] (Chu & Kim, 2011). Consequently, the utilization of traditional marketing strategies has become archaic for marketers, prompting a paradigm shift towards more innovative approaches to navigate this evolving consumer landscape.

Introducing novel products and their applications is facilitated through a prominent marketing strategy known as "influencer marketing," a concept designed by marketers to establish a meaningful connection between consumers and brands. Influencers, extending beyond conventional product endorsements, engage in a spectrum of innovative actions facilitated by the evolving landscape of social media, thereby presenting opportunities for augmenting brand value and steering purchase decisions. This strategic approach enlists influential bloggers and opinionated figures to craft, disseminate, and amplify advertising messages directly to consumers [6] (Brown & Hayes, 2008). The term "influencer" transcends traditional boundaries, as anyone leveraging user-generated content on social media platforms can evolve into a leading creator, actively contributing personal narratives and reviews on products and services. These individuals are commonly identified as social media influencers [7-9] (Freberg *et al.*, 2011; Khamis *et al.*, 2017; Lim *et al.*, 2017). Within the cosmetic industry, influencers extensively exploit social media platforms to introduce and promote beauty products, leveraging their reach and credibility to resonate with a diverse audience.

Considering the evolving landscape of consumer behavior marked by a shift from physical to digital shopping, the imperative focus lies on Generation Z, encompassing individuals born between 1997 and 2012, as identified by the Pew Research Centre. This study delves into the relatively unexplored realm of influencer marketing, a burgeoning strategy, to unravel the cosmetic product customer's perception within this demographic. The symbiotic relationship between brands and their social media influencers plays a pivotal role in establishing direct connections with key consumers and fostering brand loyalty. Despite brands lacking complete control over social media conversations, influencers act as conduits for direct word-of-mouth interactions, instilling trust in consumers and influencing their image of the brand. The study aims to aid marketers in assessing the impact of social media influencer marketing, specifically through Instagram, Facebook, and YouTube influencers, among female Generation Z and Millennial cosmetic consumers. By examining collaborations between brands and influencers, the research seeks to elucidate their role in shaping consumer perceptions and guiding purchasing decisions.

Amidst the internet's creation and the pervasive popularity of platforms like Instagram, Facebook, and YouTube, consumers now wield unlimited freedom in selecting content, posing a challenge for brands, especially in the cosmetic industry. With target audiences diversifying across various media forms, reaching them becomes increasingly arduous. Recognizing this, marketers have turned to influencer marketing as a viable solution, allowing brands to precisely target and advertise to their desired audience. Consequently, this study poses a crucial inquiry: What impact does influencer marketing wield on consumer perceptions in the cosmetic industry? Addressing this question, the research aims to bridge existing gaps, offering insights into the dynamics between influencers and consumers, and how these relationships influence the ever-evolving landscape of cosmetic purchasing decisions.

LITERATURE REVIEW

Isosuo (2016) [10] investigated the elements influencing how followers of selected influencers perceive content marketing. Conclusively, the research found that followers regard influencers as peers, assigning value to their judgments through the medium of social media. Nouri, M. (2018) [11] examined the impact of micro-celebrities on YouTube and Instagram, highlighting their ability to immerse themselves in pop culture within the fashion and beauty industry, surpassing the influence of traditional celebrities. The findings revealed a shift in consumer preferences, with social media influencers taking precedence as the primary advertising platform over traditional celebrities.



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Glucksman (2017) [12] conducted a pentadic analysis on Instagram posts and qualitative content analysis of YouTube videos featuring a social media personality. The aim was to discern the factors contributing to the success of a social media influencer in effectively communicating a lifestyle brand to their followers. The study unveiled that social media influencer marketing has dismantled the barrier between consumers and brands, fundamentally altering the dynamics of their communication. Taylor (2021) [13] acknowledged that the evolving landscape of technology, societal shifts, and public policy issues is reshaping the trajectory of advertising, paving the way for social influencers to emerge as the new face of promotional strategies.

B. G. Smith, G. Golan, and Karen (2023) [14] delineated the connections between influencers by applying principles of public relations. The outcomes of their elucidate the pivotal relational and dialogic factors inherent in influencer relations. Beheshti, M. Koorank, M. Gopinath, Sama A, and S.Zal (2023) [15] aimed to comprehend the impact of influencers' polarization on enhancing the efficacy of brand posts on Instagram. The findings suggest that marketers can leverage the existing polarization within online user communities, utilizing polarized influencers to fortify the effectiveness of their brand communication.

Campbell, Colin, and Justine R. Farrell (2020) [16] delved into the origins of influencer marketing and the various types of influencers prevalent in the current market. It discerns three primary functional components crucial to influencers: the audience, the endorser, and the social media manager. The research elucidates how the synergy of these components collaboratively reinforces the influencer's impact and effectiveness. Zhang, Lu, Wei Wei, Bobbie. R, and Y. Zheng (2023) [17] analyzed the impactful posts by pet influencers and their pronounced influence on the purchasing decisions of pet owners. The findings underscore that consumers are significantly swayed by the emotional elements embedded in these social media posts, ultimately yielding a positive impact on their purchase decisions.

Objectives

1. To determine the different factors that influence the consumer perception towards influencer marketing.
2. To measure the effect of perception towards influencer marketing on their buying behaviour.

Research Design

Research design of the study is analytical and descriptive in nature.

Sources of Data

The study employed a comprehensive approach by incorporating both primary and secondary data. Primary data collection involved administering questionnaires to gather insights from 100 respondents. Secondary data, drawn from diverse sources such as books, journals, newspapers, and the internet, complemented the primary data to ensure a robust and multifaceted research framework.

Population

The target population for this study comprises female cosmetic consumers belonging to Generation Z and Millennials, specifically aged between 10 to 25 and 26 to 41, respectively. The criteria for inclusion involve individuals who actively engage with Instagram, Facebook, or YouTube platforms.

Sampling Size

The sample size selected for the study is 100.

Sampling Method

Employing a purposive sampling approach, primary data were gathered from female cosmetic consumers in Kerala, with a particular emphasis on the Malabar region. The sample comprised 100 participants, ensuring an equal distribution of Generation Z and Millennial respondents at a ratio of 1:1.



**Jasmine and Jobin George****Data Analysis and Interpretation-part A**

Multiple regression has been conducted to measure the various factors influencing the consumer perception towards cosmetic products influencer marketing.

H₁ The variables namely credibility, personal experience, number of followers, content quality and similarity with your experience of beauty influencers have significant influence on the consumer perception towards cosmetic product influencer marketing.

H₀ The variables namely credibility, personal experience, number of followers, content quality and similarity with your experience of beauty influencers have no significant influence on the consumer perception towards cosmetic product influencer marketing.

As per the Table 1, the regression equation can be derived as follows:

Constant 1.103+ Credibility .195+ Personal Experience .125+ Number of followers .289+ Content quality .199+ Similarity .239

One unit of increase in the credibility impression about the beauty influencer have an 0.195 impact on the consumers' perception regarding cosmetic products influencer marketing. For every one unit increase in the personal experience with the beauty influencer and number of followers for the influencer, have an impacts of 0.125 and 0.289 on consumers' 'influencer perception' respectively. In the same way, content quality of the influencer have an influence of 0.199 on their perception about cosmetic product influencer. Finally, similarity in appearance and gestures of the influencer have an influence of 0.239 on their perception about cosmetic product influencer. All the identified factors resulted positive impact on consumer perception towards cosmetic products influencer marketing with less than .05 'p' value and hence, null hypotheses are rejected and alternative will be accepted.

Data Analysis and Interpretation-part B

Simple regression has been conducted to measure the effect of 'consumer perception towards cosmetic products influencer marketing' on their cosmetic product purchase.

H₁ : The consumer perception towards cosmetic product influencer marketing have a positive impact on cosmetic product purchase.

This hypothesis is tested with simple regression analysis and it is given in the table 2. The results of the analysis can be interpreted as, for one unit of increase in the consumer perception towards cosmetic products' influencer marketing have a 0.489 impact on their cosmetic product purchasing habit. Moreover other responses showing responses towards influencer marketing and their cosmetic product purchase decisions are shown in the graphs. It shows that influencer marketing have a role in consumer decision.

SUMMARY OF THE STUDY, FINDINGS AND CONCLUSION

Cosmetic brands are heavily marketed by the beauty influencers to the largely scattered consumers. The beauty influencers are heavily increasing and the word of mouth strategy in the influencer marketing campaign makes it more popularized among a wide variety of audiences. The audience are heavily depending on social media platforms and there has been an increase in the cosmetic product user in the recent times which makes the urge for the use of influencer marketing. In this backdrop this study determines the impact that influencer marketing has on cosmetic product consumers and in their perception and determines the factors that have influenced the cosmetic product customer's perception on the basis of the influencer marketing. Moreover, how this perception influence their cosmetic purchase decision is also analysed. This study determines the impact that influencer marketing has on cosmetic product consumers and in their perception and determines the factors that have influenced the cosmetic product customer's perception on the basis of the influencer marketing. Based on the research it is suggested that generation differences are to be considered in influencer marketing by cosmetic companies in order to reach wider audience and companies need to choose the best influencers for the influencer marketing and should consider factor that have impact on the consumer.





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Table 1 Model Summary

Table 1Model Summary						
Model		R	R Square	Adjusted R Square	Std. Error of the Estimate	
1		.988a	.975	.974	.755	
a. Predictors: (Constant), Similarity, Credibility, Attractiveness, Followers, Content, Personal Experience						
Table 1 Multiple Regression -Consumer perception about cosmetic product influencer marketing						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.103	.325		3.392	.001
	Credibility	1.066	.090	.195	11.853	.000
	Personal Experience	.583	.152	.125	3.833	.000
	No: of followers	1.262	.085	.289	14.787	.000



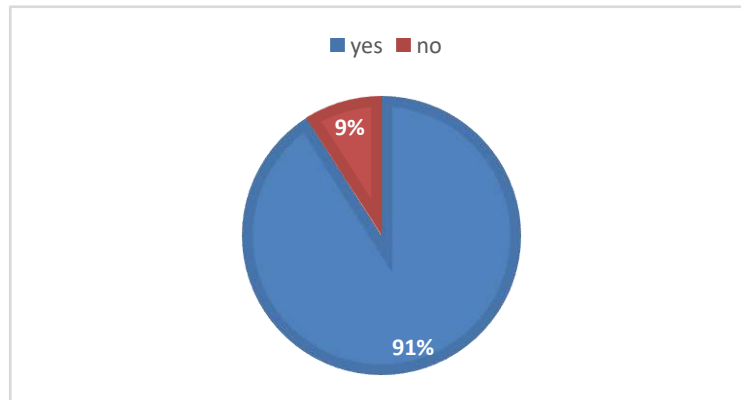


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	Content Quality	.787	.074	.199	10.670	.000
	Similarity with you	1.045	.106	.239	9.861	.000
a. Dependent Variable: consumer perception towards cosmetic product influencer marketing						

Table 2 Simple Regression -Cosmetic product purchase based on influencer perception

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.551	.442		1.247	.215
Consumer about cosmetic product influencer marketing	.129	.021	.489	6.088	.000
a. Dependent Variable: Cosmetic product Purchase					



Graphs showing responses towards influencer marketing and their cosmetic product purchase decisions.

1. Cosmetic Consumers Aware of Term 'Influencer Marketing'
2. Respondents Searching Product Recommended by Beauty Influencer





Strategies to Promote Environmental Protection Awareness and Attitude of Secondary School Students in Dindigul District, Tamil Nadu, India

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ABSTRACT

Environmental protection awareness refers to the understanding of environmental issues and the importance of preserving the environment. It involves recognizing the impact of our actions on the environment and the need for sustainable practices. The objective of this study is to investigate the impact of environmental protection awareness interventions and strategies, considering locality and media influence, on the environmental attitude of secondary school students. The study adopted a single group pre and post-test experimental design method. In this study, a purposive sampling method was used, selecting a focused group of 50 students from St. Joseph's Matriculation School in Dindigul. This study utilized various statistical techniques, including mean and standard deviation calculations for dataset analysis. The t-test was used for comparing pre and post intervention scores, and percentage analysis was conducted for understanding attitude changes. The study found that the environmental education intervention positively influenced secondary school students' environmental attitude. After the intervention, there was an overall increase in environmental attitude scores, indicating voluntary participation in environmental activities, sharing of environmental knowledge, and preference for environmentally-friendly products.

Keywords: Environmental Protection, Secondary School Students, Awareness Strategies, Environmental Education and Student Engagement





INTRODUCTION

Each individual holds the responsibility to increase awareness about various aspects of environmental protection [1]. The environmental conservation measures instituted by government entities and businesses have proven insufficient. Both sectors need to amplify their efforts for more substantial and effective environmental protection [2]. Promoting environmental protection strategies among secondary school students is a pressing issue in today's global environmental context, particularly considering current concerns around climate change, biodiversity loss, and resource depletion [3]. Secondary school students stand at the cusp of adulthood, forming personal attitudes, values, and behaviors they will carry into the future. Thereby, our modern society positions them as significant contributors towards environmental sustainability [4]. Environmental education centered on sustainability and promoting understanding of our relationship with the environment plays a crucial role [5]. It cultivates environmentally informed citizens, fostering improvements on both individual and community levels [6]. By engaging students in active, participative learning about their environment, they gain the required knowledge, attitudes, skills, and confidence to take meaningful environmental actions [7]. People often perceive sustainably-focused behaviors as burdensome, costly, or overly complicated, creating substantial barriers towards constructive attitudes about the environment [8]. Contextualizing environmental protection within students' lives and providing them with strategies to manage these challenges is crucial [9]. By doing this, students are more likely to understand the relevance of these problems to their lives, engendering a tendency to adopt environmentally friendly practices. Moreover, a comprehensive environmental education program goes beyond merely instilling knowledge [10]. Environmental protection strategies involve multidisciplinary information from sciences such as biology, ecology, meteorology, and even social sciences like sociology and economics [11]. Combined, they educate students on how their actions contribute to larger environmental systems, creating a sense of empathy and concern for their local and global communities [12]. Importantly, environmental action is not solely an individual challenge, but a collaborative effort. Schools can become 'green' models in which students can practice eco-management strategies, motivationally promoting environmental care in broader social environments [13]. However, the degree to which secondary school students implement environmentally friendly practices is relatively unexplored. Further, there is a need to monitor and promote the application of the environmental protection strategies they learn [14]. By focusing on this overlooked demographic, the study will provide valuable insights, contributing beneficially to the community, environment, and the students themselves. In this study will examine the implementation of environmental protection strategies among secondary school students, aiming to shed light on their environmental attitude, inspire further academic inquiry, and influence educational curriculum formation concerning environmental sustainability. By doing this, we hope to motivate students towards adopting sustainable life practices, raising environmentally responsible generations.

The research found significant positive effects of environmental education on environmental awareness and attitude, with an enhanced understanding expected to promote related attitude. This is aligned with the revised Environmental Protection Law in China [15]. The study found that education level, waste disposal costs, accessibility to waste collection facilities, and government regulations significantly influence waste classification and environmental protection practices among rural households. It recommends enhanced awareness programs, stronger waste disposal funding, and rigid laws to improve waste management and environmental conservation [16]. The investigation unveiled that there exists a notable, yet moderate, positive correlation between the understanding and mindset concerning the preservation of the environment [17]. The primary discovery indicates that the degree of consciousness regarding the preservation of ecological assets among B.Ed scholars is of a moderate nature [18]. The findings reveal that students from urban regions who study in English have a more developed understanding of environmental issues compared to students from semi-urban rural areas who study in Bengali [19]. [20] Investigated consumer intentions to use eco-friendly shopping bags, offering practical insights into behavioral strategies for environmental protection



**Anandakumar et al.,****Objectives**

1. To recognize the effective environmental protection strategies applicable for secondary school students.
2. To assess the effect of an environmental protection awareness of intervention on the attitude of secondary school students.
3. To assess the effect of strategies to enhance environmental protection awareness on secondary school students with respect to locality and media influence.

Hypotheses

Ho1: There is no significant effect of strategies to enhance environmental protection awareness on secondary school students, regardless of locality and media influence.

Ho2: There is no significant difference in the environmental attitude of secondary school students before and after the intervention.

METHODOLOGY

The study adopts a single group pre and post experimental design. Firstly, a pre-test is conducted to assess the participants' initial levels of awareness regarding environmental protection. Following this, an intervention or treatment is implemented aimed at enhancing participants' environmental protective attitude. This intervention is the transitional phase between the pre-test and the post-test. After the intervention, a post-test is conducted to measure the enhanced understanding and awareness of participants about environmental protection. This approach helps in closely tracking the changes in awareness levels and quantifying the effectiveness of the intervention used in the study.

Sample

The study employs purposive sampling, a type of non-probability sampling technique, to select its participants. In this method, the researcher's knowledge about the population is used to choose the sample. For this particular study, a sample of 50 students is deliberately chosen from St. Joseph's Matriculation School, Dindigul. The selection is based on the premise that these students can provide valuable, relevant, and diverse insights into the research topic. The chosen sample from this particular school may reflect a specific demographic, regional, academic, or socio-cultural perspective that the study aims to analyze and understand.

Instrument

The study employs an achievement test as a primary tool, consisting only of a post-test designed for English-medium students. The test has been developed based on expert guidance and is scored out of a total of 50 marks. The question pattern of the post-test involves various types of questions: 'Choose the correct answer' with 20 questions for 20 marks, 'Fill in the blanks' with 10 questions for 10 marks, 'Match the following' with 10 questions for 10 marks, and 'True or False' with 10 questions for 10 marks. This totals to 50 questions for the full score.

Implementation of Strategies

In this research, we employed various engaging strategies to foster environmental awareness. These strategies, aimed at different environmental topics, included 'Save trees!' via role-play; 'No Plastic Bags!' through mime; 'Air Pollution' tackled in a skit; 'Water Pollution' presented through a puppet show; 'Climate Change' explored in a video show; the issue of 'Refrigerant Poisoning' discussed in a debate; and 'Newspaper Carbon' addressed through a monoact. Post implementation of these strategies, an experimental test was conducted to evaluate their effectiveness. Among these strategies, the mime performance - focused on discouraging the use of plastic bags - was identified as the most effective learning tool for the students. This approach helped the students grasp the topic more efficiently, indicating the value of interactive and creative educational methods in enhancing learning outcomes.



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RESULTS

The table 1 shows that, the results of a Shapiro-Wilk test, conducted to assess the normality of data distribution. In both pre-test and post-test, the sample size (N) is 50, with standard deviations of 2.05 and 1.96 respectively. The Shapiro-Wilk W value is a measurement ranging from 0 to 1. Values close to 1 indicate that the distribution of data is close to normal. In this case, the W values for both pre-test and post-test are quite close to 1 (0.967 and 0.966 respectively), suggesting the data follows a relatively normal distribution. The Shapiro-Wilk p-values help us determine whether to reject the null hypothesis that the data is from a normal distribution. A p-value greater than 0.05 usually means we fail to reject the null hypothesis, indicating the data has a normal distribution. Here, the p-values for both the pre-test and post-test (0.173 and 0.158) are greater than 0.05, allowing us to assume that both datasets are normally distributed.

Ho1: There is no significant effect of strategies to enhance environmental protection awareness on secondary school students, regardless of locality and media influence.

The comparison between the pre-test and post-test scores for environmental protection awareness among 50 secondary school students is presented in Table 2. The pre-test score had a mean of 24.56 with a standard deviation of 2.05. In contrast, the post-test exhibited an increase in awareness, with a mean of 33.76 and a slightly reduced standard deviation of 1.96. By conducting a paired t-test with 49 degrees of freedom, a t-value of 25.22 was obtained. The remarkably high t-value, in conjunction with a p-value of less than 0.000, indicates a statistically significant enhancement in environmental protection awareness between the pre-test and post-test. Consequently, the null hypothesis is rejected, and the alternative hypothesis is accepted.

The table 3 shows that, a comparison between the post-test scores on environmental protection awareness of two groups of secondary school students, sorted by locality. The group of 24 students from a rural locality had a mean score of 32.29 with a standard deviation of 1.16, whereas the group of 26 students from an urban locality had a higher mean score of 35.12 with a larger standard deviation of 1.52. The t-test, run with 48 degrees of freedom, gave a t-value of 7.30. The corresponding p-value of .000 suggests that the difference in post-test scores between the rural and urban students is statistically significant, with urban students scoring higher on average. The table 4 shows a comparison of post-test scores for environmental protection awareness among secondary school students influenced by different media: social media and TV. The assemblage employing social media is composed of 30 scholars and possesses an average score of 34.50 with a standard deviation of 2.14. Conversely, the assemblage utilizing television encompasses 20 scholars and manifests a lower average score of 32.65 alongside a diminished standard deviation of 0.87. Employing 48 degrees of freedom, a t-test produced a t-value of 3.64. With a p-value of .001, the data implies a statistically significant distinction in environmental preservation consciousness amidst the two assemblages, wherein social media users demonstrate heightened levels of awareness in comparison to television.

The table 5 presents the mean scores of eight different environmental protection strategies including Role Play, Mime, Skit, Puppet Show, Drama, Video Show, Debate, and Mono act. The mean score represents the average effectiveness of each strategy, calculated from collected data. The strategy with the highest mean score is Mime, with a score of 44, suggesting that it might be the most effective strategy for environmental protection among those considered. The Puppet Show also has a high mean score of 42.6. On the other end, the strategy with the lowest mean score is Debate, at 38, indicating it might be the least effective among the assessed strategies. However, all means are relatively close to each other, which suggests that the strategies show similar levels of effectiveness. Future studies could delve deeper into determining the factors that may influence these scores and the success of different strategies.

Ho2: There is no significant difference in the environmental attitude of secondary school students before and after the intervention.

The table 6 shows that, compares the environmental attitude of secondary school students before and after an intervention. The attitude is rated on a scale, with higher scores indicating greater frequency or intensity of the attitude. Across all measures, there was an increase in scores after the intervention, suggesting that the intervention



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had a positive effect on the students' environmental attitude. For instance, before the intervention, the average score for watching TV and radio shows about the environment was 2.76, which increased to 4.02 after the intervention. Similarly, before the intervention, students' willingness to volunteer in school environment-related activities had a mean score of 3.06, which rose to 4.3 after the intervention. This trend is consistent across all the variables, which suggests the effectiveness of the intervention in enhancing students' environmental attitude. The score for sharing environmental knowledge with friends improved from 2.5 to 3.92. There was also a rise in the score for preferring to buy recyclable products, from 2.56 to 3.92, and in the score for preferring to buy environmentally-friendly products, even if costlier, from 2.7 to 4.02. These increases in scores indicate the intervention had a positive effect on improving the students' environmental attitude.

DISCUSSION

This review study shed light on the effectiveness of educational interventions in fostering environmental attitude. The research findings align with previous studies such as those by [5,7], which affirmed the significant role of education plays in strategic environmental attitude and sustainability. However, a noteworthy point of divergence from Li's study can be observed. [15] research concentrated on environmental education's effect on awareness and attitudes, whereas this review revealed that the intervention additionally reflected in distinct attitude changes. It indicates that the combination of awareness and practical involvement might result in higher impact towards environmental sustainability. Differing from Liu *et.al.*, [16] research, which focused on rural residents' environmental awareness and waste classification attitude and this study concentrated on a more comprehensive range of environmental activities among the youth. Additionally, Robelia *et.al.*, [9] conducted a review of environmental knowledge surveys, slightly similar to this study. However, beyond knowledge assessment, the current study also dissected attitude alterations post-intervention, providing a more rounded view of the effect of environmental education. In conclusion, the study aligns largely with existing research on environmental education, but offers deeper insights into potential attitude shifts resulting from educational interventions. More comparable, longitudinal studies would be advantageous for the field's ongoing progress.

CONCLUSION

The study has highlighted the importance of environmental protection awareness and the significant role of educational interventions in fostering environmentally responsible attitude. The analysis of the intervention in secondary schools revealed an increase in environmental consciousness among the students, evidenced by raised scores across various indicators. The numerous studies cited offer a broad perspective on environmental education and its capacity to inspire sustainable practices. This research underscores the necessity for ongoing and enhanced multidisciplinary efforts in environmental education to encourage responsible attitude and foster awareness. The positive outcomes from the intervention suggest that such education programs can indeed yield tangible results in the bid for environmental sustainability. Consequently, the study calls for continued emphasis on, and investment in, environmental education as a critical tool for advancing global environmental sustainability goals.

Recommendation

Based on the conclusions of this review study, the following recommendations are suggested: More emphasis should be placed on environmental education in secondary schools, given its demonstrated efficacy in increasing environmental awareness and instilling environmentally-friendly attitude. Future research should further explore the long-term effects of such educational interventions to ensure their impact is sustained over time and not limited to the duration of the intervention. The development of curricula and school programs should integrate environmental topics substantially and consistently to engage students regularly in environmental concerns. Policy makers should consider these findings in their decision-making process, by investing more resources, both financial and human, in environmental education. Businesses and industry also have a role in promoting environmental subjects and could cooperate with schools to provide practical learning experiences to deepen students'





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understanding of environmental sustainability. The success of intervention-oriented environmental education should be replicated across other learning environments, such as tertiary institutions and informal learning platforms, to broaden the impact on a wider audience. Advocacy for attitude change towards the environment should extend beyond the educational environment. Local communities and parents can be engaged with similar intervention strategies to cultivate a holistic attitude of environmental sustainability across all age groups.

Conflicts and Interest

None.

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Table 1 Data Normality Test		
Statistics	Pre-test	Post-test
N	50	50
Standard deviation	2.05	1.96
Shapiro-Wilk W	0.967	0.966
Shapiro-Wilk p	0.173	0.158

Table 2 Pre and Post test scores of environmental protection awareness of secondary school students

Test	N	Mean	S.D	df	t-value	p-value
Pre-test	50	24.56	2.05	49	25.22	.000
Post-test	50	33.76	1.96			

Table 3 Post test scores of environmental protection awareness of secondary school students with respect to locality

Locality	N	Mean	S.D	df	t-value	p-value
Rural	24	32.29	1.16	48	7.30	.000
Urban	26	35.12	1.52			

Table 4 Post test scores of environmental protection awareness of secondary school students with respect to media influence

Media influence	N	Mean	S.D	df	t-value	p-value
Social Media	30	34.50	2.14	48	3.64	.001
TV	20	32.65	0.87			

Table 5 Mean Scores of Eight Environmental Protection Strategies

Strategies	RolePlay	Mime	Skit	Puppetshow	Drama	Videoshow	Debate	Monoact
Mean	41.6	44	41.6	42.6	40	40	38	41

Table 6 Environmental Attitude of secondary school students before and after intervention

Statements	Before intervention (Mean)	After Intervention (Mean)
1. I watch TV and radio shows about the environment.	2.76	4.02
2. I read news articles on environmental topics.	2.62	4
3. I watch documentaries centered on the environment.	2.64	3.8
4. I read non-textbook books about environmental issues.	2.78	3.86
5. I read widely-known environmental magazines.	2.94	3.8
6. I read research papers about the environment.	2.78	3.8
7. I'm not afraid to criticize someone who is harming the environment.	3.02	4.2
8. I'm willing to participate voluntarily in school activities related to the environment.	3.06	4.3
9. My friends see me as environmentally conscious.	2.8	4.02



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10. I'm willing to work long hours for lower pay if it contributes to a healthier environment.	2.56	3.92
11. I share my environmental knowledge with my friends.	2.5	3.92
12. I choose to buy products that can be recycled.	2.56	3.92
13. I'd rather buy environmentally-friendly products, even if they cost more.	2.7	4.02





RESEARCH ARTICLE

Antioxidant Potential of Hydroalcoholic Extract of *Moringa oleifera* Seeds Protects Bisphenol A Induced Reproductive Toxicity in Male Albino wistar Rats

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ABSTRACT

Bisphenol A (BPA) is a globally used endocrine disruptor incorporated in many plastic industries. BPA is implicated to have hazardous consequences on reproductive health in human and experimental animals. Present study endeavor to appraise the effect of *Moringa oleifera* seeds extract against an estrogenic compound BPA. Albino Wistar rats received Bisphenol A (10 mg/kg body weight) dissolved in olive oil (5 mL/kg) orally for 28 days. The pathological alterations due to BPA were evaluated in testis tissue. Simultaneously changes in testicular hormones, sperm characteristic, biological enzymes like antioxidant enzymes, elevated peroxide levels were measured as a marker of reproductive toxicity in rats. Oral administration of *Moringa oleifera* seeds extracts (100 & 200 mg/kg body weight) in BPA intoxicated rats reduced the testicular biochemical and morphological changes and were reversed back to normal. Antioxidant potential of *Moringa oleifera* seeds, ameliorates the BPA induced changes.

Keywords: Bisphenol A, Rats, Testis, Reproductive Toxicity, Antioxidants.





INTRODUCTION

Bisphenol A (BPA, 2,2-bis(4-hydroxyphenyl) propane) is a chemical used mainly in the manufacture of polycarbonate plastics and epoxy resins and also as an additive non-polymer to other plastics. BPA is extensively used in the manufacture of consumer goods and products, including polycarbonate food containers and dental sealants, utensils, protective coatings, water supply pipes and some flame retardants, there is a widespread and well-documented human exposure to BPA (1,2). Endocrine disrupting chemicals (EDCs) are an important class of chemicals that interfere with the production, release, transport, metabolism, binding, action, and excretion of natural hormones in the body and are responsible for the maintenance of homeostasis of developmental processes. These chemicals in the environment have estrogenic activity. Some of the common EDCs include Bisphenol A (BPA), phthalates and certain pesticides (3). BPA is a synthetic chemical and not present in the environment. It is released into the environment as effluent discharge from industries. Post consumer sources of BPA include effluent discharge from waste combustion, or degradation of plastics in the environment, from wastewater treatment plants. Photodegradation is the main method of BPA degradation in the environment.

BPA is considered to have only moderate bioaccumulation and has a low volatility and relatively short half-life in environment and biological tissues (4). BPA has been linked to various pathological conditions including cardiovascular diseases, cancers and reproductive disorders. BPA adversely affects testis and in particular male reproductive system (5,6). BPA administration has been shown to reduce the sperm count and testis weight, levels of reproductive hormones and induce oxidative stress and disrupt blood–testis barrier (7, 8, 9). Molecular studies have revealed many potential mechanisms of the effects of BPA on sperm. Among these mechanisms, the accumulation of reactive oxygen species (ROS) attracted attention from researchers (10, 11). *Moringa oleifera* belongs to the plant family, Moringaceae and is used as nutritional supplement and for medicinal purposes throughout the world especially in Asia and Africa. It is also known as drumstick tree (12). *Moringa oleifera* has significant number of phytochemicals such as flavonoids, phenols, alkaloids, glycosides, vitamins, sterols, minerals, and amino acids in leaves, seeds, and fruits (13,14). Seeds of *Moringa oleifera* has diuretic activity (15) as well as antimicrobial and antitumor activities (16). Aqueous and ethanolic *M. oleifera* seed extract (MSE) has been shown to possess various pharmacological activities such as anti-oxidant, anti-arthritis, anti-asthmatic, hepatoprotective effects (17). Phytochemical investigations to isolate the bioactive compounds from the seeds of *Moringa oleifera* resulted in the isolation of glycosides such as niazimicin and niazirin, 4(alpha-L-rhamnosyloxybenzylglucosinolate), Moringa oil and beta-sitosterol (18, 19).

MATERIALS AND METHODS

Preparation of Hydro alcoholic Extract of *Moringa oleifera* seeds (HAEMS)

Dried Pods of *Moringa oleifera* seeds were collected from different localities in the city of Ananthapuramu, Andhra Pradesh, India. The pods were broken to expose the winged and coated seeds and coatings were removed, the kernel seeds were collected. Collected seeds were dried at room temperature for several weeks. The extraction was done by cold maceration method using 80:20 ratio of ethanol and water. Dried seeds were blended to coarse powder and 500g powder was weighed and soaked in 80% ethanol for 48 hours with occasional shaking and filter. The filtrate was evaporated by distillation under low temperature (45°C) and obtained extract was transferred into china dish. Air dried and stored at room temperature for further use. The resultant yield of extract is 34 g of dry weight.

Experimental animals

Adult healthy male albino Wistar rats weighing 150-200 gms were used in this study and procured from Sri Venkateshwara Enterprises, Bangalore. All animals were maintained in plastic cages at 22 ± 3 °C under a 12 h light/dark cycle and had free access to pellet food and water. Rats were acclimatized for at least 1 week to the



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laboratory conditions, all the experiments were carried out according to the study protocol approved by the Institutional Animal Ethical Committee [1677/PO/Re/S/2012/ CPCSEA/IAEC/35/dt 23/2/19].

Experimental protocol

Rats were divided into four groups and each group consisted of six animals. First group animals received 1 ml of emulsion of olive oil orally for 28 days served as vehicle treated control. Second group animals were administered orally Bisphenol A (10 mg/kg) dissolved in olive oil (1 mL) for 28 days. Third and fourth group animals received Bisphenol A along with HAEMS (100 and 200 mg/kg) respectively orally for 28 days.

Sample collection

At the end of the experiment, the rats were weighed, and sacrificed through cervical dislocation. Blood samples were collected from heart and the serum was separated by centrifugation at 2000rpm at 4°C for 10 minutes, these samples were stored at -20°C until further analysis. The abdominal region was wiped with normal saline, scrotum was dissected to expose the testes, epididymis and extraneous connective tissues were trimmed, right and left testis from each rat in the experimental groups were weighed. The right testis was fixed with buffered 10% formaldehyde solution for histological evaluations. The left testis was washed 2 to 3 times with saline and was homogenized in 0.1 M Tris-HCl buffer (pH 7.4). The homogenate was subjected to differential centrifugation and was used for the biochemical assays.

Biochemical Estimation

Epididymal sperm were counted with a hemocytometer, Sperm morphology was scored (20), FSH, LH and testosterone were estimated by using ELISA kit, The level of lipid peroxides by Ohkawa et al., 1979 method (21), superoxide dismutase activity by the method of Misra and Fridovich (1972) (22), the activity of catalase by Sinha et al., (1972) (23), glutathione peroxidase by Jagetia et.al., (2003) (24), Glutathione by Ellsmam et al., method (1972) (25)

Histological Study

Testis was fixed with buffered 10% formaldehyde solution, embedded in paraffin, sectioned and stained routinely with hematoxylin and eosin, and was observed microscopically. Tissue slices were photographed using optical microscope at 40x magnification.

Statistical analysis

All values were expressed as Mean \pm SD. The statistical analysis was performed using one way ANOVA followed by Tukey's multiple comparison test. The statistical significance was set at ($p < 0.05$). Prism graph pad (version 8.20) was used for the analysis of the data.

RESULTS**Effect of HAEMS on body weight and organs of male reproductive system on Bisphenol A induced toxicity**

BPA treatment 10 mg/kg for 28 days significantly decreased body, testes, epididymis and seminal vesicles weight, prostate gland compared to normal control group. HAEMS 100 & 200 mg/kg/p.o significantly reversed BPA induced decrease in body, testes, epididymis and seminal vesicles weight. The results were given in the (Table 1).

Biochemical Estimations**Effect of HAEMS on testicular oxidative stress markers on Bisphenol A induced toxicity**

BPA treatment 10 mg/kg for 28 days significantly increased MDA levels compared to normal control group. HAEMS 100 & 200 mg/kg significantly reversed BPA induced increase in MDA levels. BPA treatment 10 mg/kg for 28 days significantly decreased GSH, GPx SOD and CAT levels compared to normal control group. HAEMS 100 & 200 mg/kg significantly reversed BPA induced decrease in GSH, GPx SOD and CAT levels. The results were given in the (Table 2).





Hormonal analysis

Effect of HAEMS on serum testosterone level in Bisphenol A induced toxicity in male rats.

BPA treatment 10 mg/kg for 28 days significantly decreased serum testosterone, luteinizing hormone, follicle stimulating hormone level compared to normal control group. HAEMS 100 & 200 mg/kg/p.o significantly reversed BPA induced decrease in serum testosterone, luteinizing hormone, follicle stimulating hormone level. The results were given in the (Table 3).

Effect of HAEMS on Sperm count in Bisphenol A induced toxicity in male rats.

BPA treatment 10 mg/kg for 28 days significantly decreased Sperm count, motility, viability and increased abnormal sperms as compared to normal control group. HAEMS 100 & 200 mg/kg/p.o significantly reversed BPA induced alterations Sperm quality and quantity (Table 4).

Histological investigation

Photomicrographs of testis tissue of the normal group showed normal architecture of testicular tissue with active spermatogenesis in seminiferous tubules (Fig: 2). The BPA induced group revealed remarkable degenerative changes, disorganization and necrosis of the histological structure of seminiferous tubules. Abnormal appearance with respect to the number of mature sperms with obvious loss in seminiferous tubules, sertoli cells, and germ cells arranged disorderly and decreased in quantity, especially for mature sperms and elongated spermatids. Leydig cell degeneration and increment in inter tubular space were also observed. Testis tissue of HAEMS (100, 200mg/kg, respectively) treated groups showed increased number of leydig cells and significantly increased mature sperms in seminiferous tubules with the increase of Sertoli cells and germ cells were arranged orderly (Figure 1).

DISCUSSION

The toxic effects of environmental endocrine disruptors on the human reproductive system are of major health concern, which are strongly associated with reproductive dysfunction in both animal and human populations. BPA is one of the potential environmental endocrine disruptor that has serious harmful effects on the reproductive system. BPA exposure decreases the sperm count, motility, viability (26). Previous reports showed that BPA caused a decrease in sperm quality in rodents and humans (27). BPA induced toxicity decreased weight of paired testes (26), diameter of seminiferous tubules and thickness of epithelium (28,29). The body weight gain is one of the comprehensive indicators for assessing health condition of rats treated with chemicals. The data of the present study showed a significant decrease in body weight gain and testicular weight of rats was decreased, which indicated that administration of 10 mg/kg/day BPA changed the metabolic activity of the rats and is a consequence of BPA induced inhibition of spermatogenesis, decreasing elongated spermatids and steroidogenic enzyme activity respectively.

Treatment with HAEMS increased the body weight and reproductive organs weight (testes, epididymis, seminal vesicles, prostate gland) in BPA treated rats. It is a well confirmed fact that sperm count, motility and viability in mammals are regulated by two gonadotropins, LH and FSH. FSH binds with receptors in the sertoli cells and directly stimulates spermatogenesis. In our study BPA treatment for 28days decreased gonadotropins, it is well established that BPA-treated animals had very low levels of LH, FSH, testosterone (30), which indicate the cause of spermatogenesis failure. Treatment with HEAMS significantly ameliorated the BPA induced reduction in serum LH, FSH and testosterone levels in a dose dependent manner. LH stimulates the production of testosterone in Leydig cells, which in turn may act on the Sertoli and peritubular cells of the seminiferous tubules and indirectly stimulates spermatogenesis via testosterone (31, 32). Oxidative stress is one of the important factor in testicular structural damage and dysfunction. Oxidative stress affects motility by altering axoneme structure that leads to tail abnormality in sperm (33) and decrease in sperm motility (34). In the present study, we observed a decrease in testicular antioxidant enzymes with a concomitant increase in the level of lipid peroxides, indicating BPA at the given dose induced oxidative changes in the testis. Previous studies also reported that BPA causes oxidative stress that is characterized by excessive reactive oxygen species (ROS) and imbalance between ROS and the antioxidant



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defense system in testis (35-37). BPA administered orally to male rats at a dose of 10 mg/kg for 14 days led to a decrease of testicular antioxidant enzymes including GSH, GPx, SOD, and Catalase (26). HAEMS treatment increased the testicular antioxidants levels (SOD, GSH, GPx, Catalase) and decreased the testicular MDA levels, this may due to the presence of flavanoids and saponins HAEMS. Flavonoids are well known antioxidants that can ameliorate oxidative stress- related testicular impairments in animal tissues (38).

It also stimulates testicular androgenesis and is essential for testicular differentiation, integrity, and steroidogenic functions (38). Administration of HAEMS at the dose of 100 & 200 mg/kg, significantly ($P < 0.001$) increased the epididymal sperm (motility, sperm count, normal morphology, viability) in BPA treated rats. The mechanism of HAEMS action on sperm viability and motility was not elucidated in the current study. It is possible that HAEMS improves sperm viability via suppression of cell death signaling. BPA group revealed remarkable degenerative changes, disorganization and necrosis of the histological structure of seminiferous tubules. Abnormal appearance with respect to the number of mature sperm with obvious loss in seminiferous tubules, sertoli cells, and disorderly arranged germ cells. Leydig cell degeneration and increment in intertubular space were also observed. Previous report also demonstrated that the lumen of the tubes were reduced and filled with immature cells belonging to the spermatogenic lineage and macrophages, suggesting an effect of BPA on the testicular tissue (29).

HAEMS(100 & 200 mg/kg) showed increase in number of leydig cells and sertoli cells, mature sperms in seminiferous tubules and orderly arranged germ cells. From the outcome of our results, we conclude that antioxidant potential of HAEMS protects BPA induced reproductive toxicity. Thus the results of this study demonstrated that BPA destructs the testis tissue and reduce spermatogenesis and decrease antioxidants levels in testis tissue (GSH, SOD, GPx, Catalase) and significant increase in lipid peroxidation. And also decreased luteinizing hormone, follicle stimulating hormone, testosterone levels. And lowers the sperm count, sperm motility, sperm viability and increased number of abnormal sperms. In histology BPA group revealed remarkable degenerative changes, disorganization and necrosis of the seminiferous tubules. Treatment with HAEMS(100 & 200 mg/kg/p.o) reversed decrease in body weight and reproductive organs weight, antioxidants levels, serum LH, FSH, testosterone, sperm count, sperm motility, viability and decrease in lipid peroxidation and abnormal sperms. Histological testis tissue of HAEMS(100 & 200 mg/kg) showed increase in the number of leydig cells and mature sperms in seminiferous tubules with the increase of Sertoli cells and orderly arranged germ cells. Our results showed that concurrent treatment with HAEMS(100 & 200 mg/kg/orally for 28 days) prevented the testicular toxicity of BPA exposure and this is evidenced by an enhancement in the testicular morphology and an improved sperm count, motility, viability and serum LH, FSH, testosterone, antioxidants (GSH, GPx, SOD, Catalase) and decrease in testicular MDA, abnormal sperms.

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Table-1: Effect of HAEMS on body weight and organs of male reproductive system on Bisphenol A induced toxicity

S. No	Group	Body weight (g)	Testes weight (g)	Epididymis weight(g)	Seminal vesicle weight (g)	Prostate gland weight (g)
1	Normal Control Group	141.0 ± 0.6325	1.926 ± 0.05603	0.8917± 0.0344	0.2770±0.0394	0.09517 ± 0.0042
2	BPA Induced Group (10 mg/kg/p.o)	115.8±0.7150 ***	0.8585 ± 0.04977 ***	0.6450±0.0314 ***	0.1448± 0.0315 ***	0.04750±0.0052 ***
3	HAEMS Low Dose (100 mg/kg/p.o)	121.7±0.7228 ***, +++	1.400±0.06331 ***, +++	0.8433±0.0406 +++	0.1987±0.0264 **, +	0.06292±0.0060 ***, ++





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4	HAEMS High Dose (200 mg/kg/p.o)	159.2±0.7320 ***, +++	1.559± 0.05275 ***, +++	0.9173±0.0437 +++	0.2603±0.0340 +++	0.09272±0.0049 +++
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Values are expressed as Mean ±SD (n=6), Analyzed by one-way ANOVA followed by Tukey's multiple comparison test, *p<0.05, **p<0.01, ***p<0.001 Vs Normal Control Group, +p<0.05, ++p<0.01, +++p<0.001 Vs BPA Induced Group

Table-2: Effect of HAEMS on testicular oxidative stress markers in Bisphenol A induced toxicity

S. No	Group	MDA levels (μmoles of MDA/mg of protein)	SOD levels (U/ml)	Catalase levels(μmoles of H ₂ O ₂ -consumed /min/mg tissue)	GSH levels (μg of GSH/ mg wet tissue)	Glutathione peroxidase (μmoles of glutathione oxidized/mg protein/min)
1	Normal Control Group	0.05202 ± 0.0026	2.047 ± 0.1258	19.89 ± 0.356	0.2572±0.0059	21.70 ± 2.240
2	BPA Induced Group (10 mg/kg/p.o)	0.09067± 0.0044 ***	1.378± 0.1441 ***	11.70 ± 0.551***	0.1872±0.0069 ***	12.52 ± 2.401 ***
3	HAEMS Low Dose (100 mg/kg/p.o)	0.05548±0.0051 +++	1.730 ± 0.1267 *, ++	15.74±0.3198 ***, +++	0.2317±0.0049 ***, +++	16.58 ± 2.526 *
4	HAEMS High Dose (200 mg/kg/p.o)	0.05260±0.0030 +++	1.929±0.1169 +++	18.21±0.443*, +++	0.2513±0.0034 +++	20.22 ± 2.439 +++

Values are expressed as Mean ±SD (n=6), Analyzed by one-way ANOVA followed by Tukey's multiple comparison test, *p<0.05, **p<0.01, ***p<0.001 Vs Normal Control Group, +p<0.05, ++p<0.01, +++p<0.001 Vs BPA Induced Group





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Table 3: Effect of HAEMS on serum testosterone, luteinizing and follicle stimulating hormone levels on Bisphenol A induced toxicity

S. No	Group	Testosterone (ng/ml)	Luteinizing hormone (mIU/ml)	Follicle stimulating hormone (mIU)
1	Normal Control Group	2.743 ± 0.0040	0.236 ± 0.0044	0.2517 ± 0.0530
2	BPA Induced Group (10 mg/kg/p.o)	0.4322 ± 0.0043***	0.1418 ± 0.0017 ***	0.1000 ± 0.0167 ***
3	HAEMS Low Dose (100 mg/kg/p.o)	0.612 ± 0.0055 ***, +++	0.196 ± 0.0013 **, +++	0.1238 ± 0.1357 ***
4	HAEMS High Dose (200 mg/kg/p.o)	2.274 ± 0.0057 ***, +++	0.230 ± 0.0054 *, +++	0.818 ± 0.0312 ***, +++

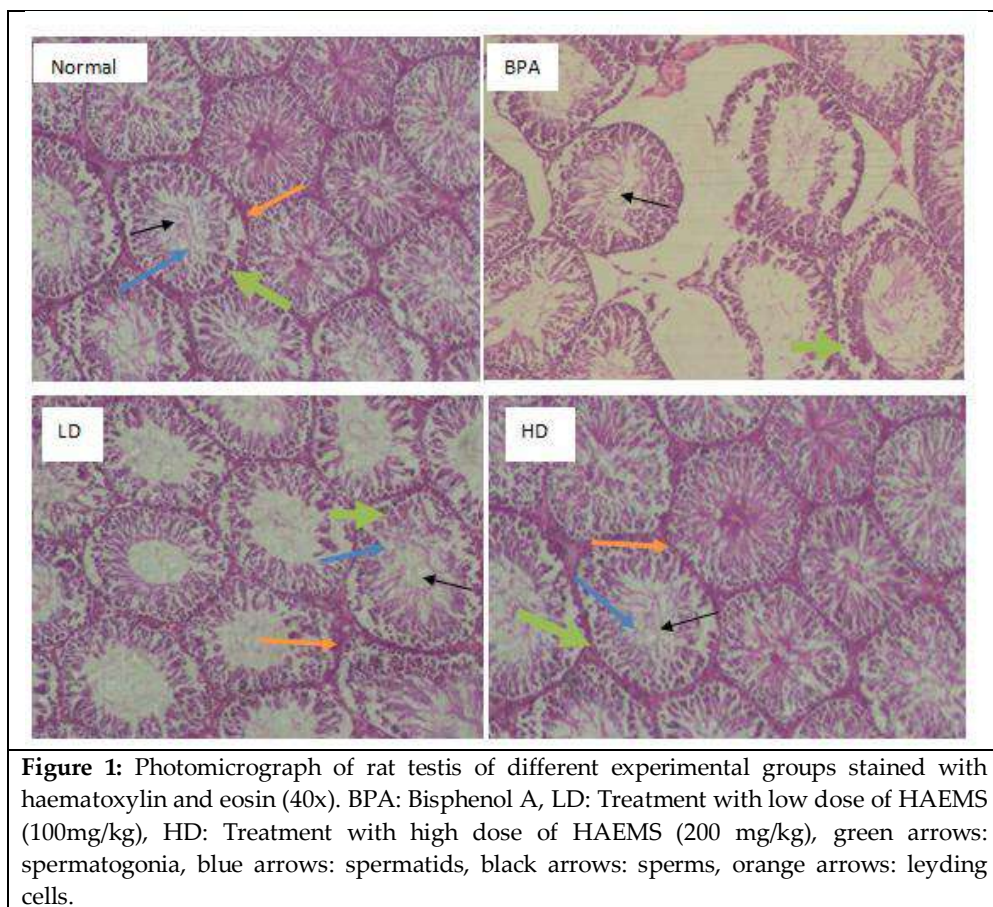
Values are expressed as Mean ±SD (n=6), Analyzed by one-way ANOVA followed by Tukey's multiple comparison test, *p<0.05, **p<0.01, ***p<0.001 Vs Normal Control Group, +p<0.05, ++p<0.01, +++p<0.001 Vs BPA Induced Group

Table-4: Effect of HAEMS on quantitative and qualitative aspects of Sperm on Bisphenol A induced toxicity

S. No	Groups	Sperm count (million/ml)	Sperm motility (%)	Sperm viability (%)	Abnormal sperms (%)
1	Normal Control Group	18.36 ± 0.2213	82.67 ± 0.7165	75.50 ± 1.225	17.00 ± 1.265
2	BPA Induced Group (10 mg/kg/p.o)	12.59 ± 0.1756 ***	50.33 ± 0.5164 ***	52.67 ± 1.211 ***	41.00 ± 1.095 ***
3	HAEMS Low Dose (100 mg/kg/p.o)	15.39 ± 0.2074 ***, +++	72.00 ± 0.6325 ***, +++	63.83 ± 1.169 ***, +++	22.67 ± 1.033 ***, +++
4	HAEMS High Dose (200 mg/kg/p.o)	17.44 ± 0.2630 ***, +++	85.50 ± 0.5477 ***, +++	71.00 ± 1.265 ***, +++	19.33 ± 1.211 *, +++

Values are expressed as Mean ±SD (n=6), Analyzed by one-way ANOVA followed by Tukey's multiple comparison test, *p<0.05, **p<0.01, ***p<0.001 Vs Normal Control Group, +p<0.05, ++p<0.01, +++p<0.001 Vs BPA Induced Group







RESEARCH ARTICLE

Guardians of Memory: Assessing *Psidium guajava* Fruit's Anti-Cholinesterase Activity through TLC Bioautography for Alzheimer's Disease Intervention

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ABSTRACT

Alzheimer's disease is a neurodegenerative condition that is characterized by a loss in cognitive function, and it is becoming an increasingly significant worldwide health issue. This study explores the potential therapeutic applications of *Psidium guajava* fruit extracts in the context of innovative therapies for Alzheimer's Disease. The study employs a comprehensive methodology, commencing with Soxhlet extraction employing a range of solvents. The findings underscore the significant influence of solvent selection, as evidenced by the notable yield of 16.6% achieved with ethanol and the subsequent yield of 10.7% obtained with methanol, so underscoring the effect of solvent polarity on the production of compounds. The phytochemical analysis conducted in this study provides a comprehensive examination of the existence of numerous phytochemical substances across different fractions. Notably, the ethanol fraction exhibits a significant abundance of alkaloids, phenols, flavonoids, and saponins. Evidence of anticholinesterase activity is offered through the utilisation of a Thin Layer Chromatography (TLC) Bioautography assay, which showcases the extract's capacity to impede the activity of acetylcholinesterase. The lack of false positives observed in the experiment serves to enhance the extract's specificity in terms of its inhibitory effects. The present work highlights the potential of *Psidium guajava* fruit extracts as viable contenders for intervening in Alzheimer's disease.

Keywords: Alzheimer's, Guava, TLC Bioautography, Anticholinesterase, Phytochemicals





INTRODUCTION

Alzheimer's disease (AD) represents a growing global health challenge, characterized by progressive cognitive decline, memory impairment, and compromised daily functioning [1]. As the aging population continues to expand, the prevalence of AD is expected to rise, underscoring the urgent need for innovative and effective therapeutic approaches to mitigate the burden of this devastating neurodegenerative disorder [2]. Existing pharmacological treatments for AD primarily focus on symptomatic relief and the modulation of neurotransmitter levels; however, these interventions do not address the fundamental neuropathological processes associated with the disease [3]. In the pursuit of novel therapeutic avenues, attention has turned to the exploration of natural compounds as potential agents for AD intervention [4]. Specifically, compounds with anti-cholinesterase activity have garnered significant interest due to their ability to modulate cholinergic neurotransmission [5-7]. Cholinesterases, namely acetylcholinesterase (AChE) and butyrylcholinesterase (BuChE), are enzymes critical for the breakdown of acetylcholine, a neurotransmitter vital for memory and cognitive function [8]. Inhibiting these enzymes can enhance acetylcholine levels in the brain, potentially ameliorating the cognitive deficits observed in AD. *Psidium guajava*, commonly known as guava, is a tropical fruit recognized for its rich repository of bioactive compounds, including flavonoids, tannins, alkaloids, and essential oils [9-11]. Previous research suggests that *Psidium guajava* leaves may possess anti-cholinesterase properties, positioning it as a promising candidate for AD intervention.

However, comprehensive exploration and precise characterization of its fruits anti-cholinesterase activity are necessary to elucidate its therapeutic potential fully [12,13]. Thin-layer chromatography (TLC) bioautography, a powerful analytical technique, offers an effective means to separate and identify bioactive compounds within complex mixtures [14-16]. By combining this approach with bioassays designed to measure cholinesterase inhibition, the anti-cholinesterase activity of *Psidium guajava* fruit extracts can be accurately evaluated. Profound understanding of the bioactivity and composition of *Psidium guajava* extracts through TLC bioautography holds significant promise for identifying bioactive components critical for potential therapeutic interventions against AD. This study endeavors to assess the anti-cholinesterase activity of *Psidium guajava* fruit extracts utilizing the TLC bioautography approach. The outcomes of this research are anticipated to shed light on the bioactive constituents present in *Psidium guajava*, thereby advancing our understanding of its potential application in the development of novel anti-cholinesterase agents for the management of Alzheimer's disease. Such advancements are crucial in fulfilling the unmet need for effective therapeutic modalities that target the underlying pathophysiology of AD, aiming for enhanced quality of life and improved disease management for affected individuals and their families.

METHODOLOGY

Collection and authentication of plant material

The fruits and leaves of *Psidium guajava* were collected from Kakching district of Manipur, India. The fruits of *Psidium guajava* were cut into small pieces and shade dried and powdered (Figure 1, Figure 2). Authentication of aerial parts of plant was done from Gauhati University, Assam, India with accession number GUBH19975.

Soxhlet Extraction

Soxhlet extraction apparatus has been used widely for extracting valuable bioactive compounds from various natural sources that are sufficiently thermally stable. It is a continuous extraction process where the solid matter can be extracted with a polar or non-polar solvent by using the solvent reflux and siphon principle [17,18]. The percentage yield was obtained using dry weight, from the equation below. The extracts were kept and stored in refrigerator.

$$\% \text{Yield of extract (g/100 g)} = (W1 \times 100) / W2$$

Where W1 is the weight of the extract residue after solvent removal and W2 is the weight of initial dried sample powder provided.



**Kunal Bhattacharya et al.,****Extraction in the order of polarity of solvents**

The round bottom flask and thimble was cleaned properly with soap and water and dehydrated well before use. The sample was weighed and 100gms each was put in the extraction chamber directly.

1. 100 gm sample in 200 ml Hexane
2. 100 gm sample in 200 ml Ethyl Acetate
3. 100 gm sample in 200 ml Chloroform
4. 100 gm sample in 200 ml Methanol
5. 100 gm sample in 200 ml Ethanol
6. 100 gm sample in 200 ml Water

The respective solvents were poured until the cycle completes through siphon tube and solvent drops down in the round bottom flask (rbf) upto half the capacity of rbf. The condenser was fitted above the upper end of the thimble and all the pipelines for inflow of water for cooling the condenser was set. The whole setting was placed in the heating mantle and the desired temperature (50-60°C for non-polar; 60-70°C for mid-polar; and 80-90°C for polar) was set in the heating mantle. The solvent was allowed to boil and the process continued for 24 hours (8hrs/day for 3 days). On completion, the unit was allowed to cool down, followed by which all the solvent approximately 125ml was collected after extraction and processed further for condensing liquid sample to semi solid form.

Phytochemical analysis of Individual fractions

The crude fractions obtained earlier were subjected to different qualitative phytochemical screening to identify the presence of various phyto constituents as described by Harborne [19]. Qualitative phytochemical screening tests are described below:

Tests for carbohydrates**Molisch test**

2 ml of the fraction was mixed with 1 ml of alcoholic α -naphthol solution and conc. H_2SO_4 was added drop wise through the side wall of the test tube. Purple ring formation at the junction of the two liquids revealed presence of carbohydrate.

Fehling's test

2 ml of fraction was mixed 1 ml of dilute HCl and heated over water bath for 10 minutes. Equal quantities of Fehling's A & B solutions were added to it and heated again. Formation of brick red precipitate indicated presence of reducing sugar.

Benedict's test

5 ml of Benedict's reagent and 1 ml of fraction was boiled for 2 minutes and cooled. Formation of red precipitate indicated presence of carbohydrate.

Test for proteins and amino acids**Biuret test**

2 ml of fraction and NaOH was mixed and 1% CuSO_4 was added. Formation of violet colour indicated the presence of proteins.

Xanthoprotein test

2 ml of fraction was boiled with 1 ml of conc. HNO_3 and cool and 20 % of NaOH was added. Formation of orange color indicated presence of aromatic amino acid.

Lead acetate test

2 ml of fraction was mixed with 1 ml of lead acetate solution. Formation of white ppt. indicated presence of proteins.



**Kunal Bhattacharya et al.,****Ninhydrin test**

To 2 ml of fraction two drops of freshly prepared 0.2% Ninhydrin in acetone was added. Development of violet color indicated presence of amino acids.

Test for alkaloids

A small portion of the solvent free fractions were stirred separately with a few drops of dilute hydrochloric acid and filter and subjected for following tests.

Dragendorff's test

To 2 ml of fraction, 1 ml of Dragendorff's reagent was added. The formation of orange red precipitate indicated presence of alkaloid.

Wagner's test

To 2 ml of fraction, 2 ml of Wagner's reagent was added. The formation of reddish-brown precipitate indicated presence of alkaloid.

Mayer's test

To 2 ml of the extract, 2 ml of Mayer's reagent was added. The formation of cream color precipitate indicated presence of alkaloid.

Hager's test

To 2 ml of fraction, 2 ml of Hager's reagent was added. The formation of yellow precipitate indicated presence of alkaloid.

Test for glycosides**Legal test**

2 ml of fraction was dissolved in pyridine and sodium nitroprusside was added. Formation of pink color indicated presence of cardiac glycoside.

Baljet test

2 ml of fraction was mixed with 2 ml sodium picrate solution. Formation of orange color revealed the presence of cardiac glycoside.

Borntrager's test

2 ml of fraction was boiled with dilute H_2SO_4 and extracted with benzene. The benzene layer was treated with strong ammonia. Formation of cherry pink color indicated presence of anthraquinone glycoside.

Test for saponins**Foam test**

2 ml of fraction was shaken with 5 ml of distilled. A 1cm layer of foam stable at least for 30 sec, indicated presence of saponin glycoside.

Test for coumarin

2ml of fraction was made alkaline by adding strong solution of NaOH and observed under UV light. Bluish fluorescence indicated presence of coumarin glycoside.

Test for steroids**Libermann-Burchard test**

2 ml of fraction was mixed with 2 ml of chloroform and acetic anhydride. 2 drops of conc. H_2SO_4 was added through the side of the test tube. Formation of deep green color indicated presence of steroid.



**Kunal Bhattacharya et al.,****Salkowski test**

2 ml of fraction was mixed with 2 ml chloroform. 2 drops of conc. H_2SO_4 was added through the side of test tube. Formation of blood red color indicated presence of steroid.

Test for flavonoids**Shinoda test**

2 ml of fraction was added with few magnesium turnings and few drops of conc. HCl. Formation of red color indicated the presence of flavonoids.

Test for phenolic compounds and tannins**5% alcoholic FeCl_3 test**

2 ml of fraction was mixed with 2 ml of 5% alcoholic FeCl_3 . Formation of deep green color indicated presence of tannins.

Lead acetate test

2 ml of fraction was mixed with 2 ml of saturated solution of lead acetate. Formation of white ppt. indicated presence of tannins.

Bromine water test

2ml of fraction was mixed with 2 ml of saturated solution of bromine-water. Discoloration of bromine water indicated presence of tannins.

Test for carboxylic acid

2ml of fraction was mixed with 2 ml of 1% KMnO_4 and dilute H_2SO_4 . Color of KMnO_4 disappeared immediately.

TLC Bioautography

By using the sonication process, 1 gram of dried powdered plant material was extracted with 10 milliliters of ethanol, resulting in a concentration of 10 milligrams per milliliter. After that, 5 microliters of each sample and 5 microliters of 0.1mM galantamine hydrobromide (Sigma) that had been dissolved in ethanol were spotted on a Merck Silica gel 60 F254 pre-coated TLC plate that measured 0.2 millimeters in thickness. The chromatogram was produced in a mixture of 7 parts chloroform to 3 parts methanol. Following the development of the TLC plate, Ellman's approach was utilized to identify enzyme inhibition [14,20]. The TLC plate was treated with a solution containing 5 millimolar concentration of acetylthiocholine iodide (ATCI) and 5 millimolar concentration of 5,5'-dithiobis-(2-nitrobenzoic acid) (DTNB) in 50 millimolar Tris-HCl buffer at pH 8, until the saturation of the silica was achieved. The plate was subjected to a horizontal drying process lasting for a period of 3 to 5 minutes. Subsequently, it was treated with a solution containing 3 units per milliliter of acetylcholinesterase (AChE) obtained from electric eel (type VI-s, lyophilized powder, 317 units per milligram solid, 500 units per milligram protein) (Sigma) that had been dissolved in 50 millimolar Tris-HCl buffer with a pH of 8, and maintained at a temperature of 37 degrees Celsius. Following a period of approximately five minutes, a yellow-hued background emerged, containing white-colored spots indicative of compounds that inhibit the enzyme acetylcholinesterase (AChE). The aforementioned phenomena were documented and noted within a 15-minute timeframe, as the white spots were no longer apparent beyond the 20-minute mark.

False positive test

A TLC plate, which was similar to the TLC plate assay, was generated in the absence of plant extract to evaluate the occurrence of erroneous positive reactions. Following the development of the thin-layer chromatography (TLC) plate, it was subjected to a spray of 5 millimolar 5,5'-dithiobis (2-nitrobenzoic acid) (DTNB) and subsequently treated with acetylthiocholine iodide (ATCI) and acetylcholinesterase (AChE) in a sequential manner. If After 5mins, a yellow background appears; the occurrence of white spots indicates false-positive reaction. The detection limit was measured by the application of 5 μl of galantamine at different concentrations (ranging from 5mM to 5 μM) onto a



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TLC plate. The detection limit refers to the minimum concentration that can be recognized by the human eye under normal conditions [21].

RESULTS

Soxhlet Extraction

The percentage yield of extracted compounds for each solvent is presented in Table 1 and Figure 3. The results clearly indicate that the choice of solvent significantly influences the yield of extracted compounds, demonstrating the importance of considering solvent polarity in the extraction process.

Phytochemical analysis

The crude ethanolic extracts of *Psidium guajava* showed presence of diverse phytochemicals in their respective fractions. A total of 5 different fractions were subjected to preliminary phytochemical screening viz. alkaloids, phenols, flavonoids, saponins, phytosterols and triterpene, tannins, carbohydrates, proteins, carboxylic acid and coumarins. The results are tabulated in the Table 2.

TLC Bioautography

The TLC assay revealed a detection limit of 3 mg ml⁻¹ for a single spot of galantamine. The ethanolic extract of *Psidium guajava* fruits was subjected to TLC analysis, which revealed the presence of two inhibiting zones that appeared white in color. The inhibiting zones were observed at concentrations of 5 mg ml⁻¹ and 10 mg ml⁻¹, respectively. Moreover, in the assay for false positives, there were no such zones observed. The screening outcomes revealed that the extract of *Psidium guajava* fruit possesses the ability to inhibit acetylcholinesterase. The results are represented in Figure 4

DISCUSSION

The study aimed to comprehensively investigate the potential of *Psidium guajava* fruit as a therapeutic intervention for Alzheimer's disease. The research utilised the Soxhlet extraction technique to get extract from *Psidium guajava* fruit using a range of solvents, including hexane, ethyl acetate, chloroform, methanol, and ethanol. The results of this extraction procedure revealed the significant influence of the selection of solvents on the quantity of chemicals extracted. Significantly, ethanol demonstrated superior solvent efficiency, resulting in an impressive yield of 16.6%, whilst hexane exhibited the lowest yield of 1.4%. This highlights the significant importance of solvent polarity in the extraction procedure, as polar solvents exhibit enhanced extraction efficiency for polar molecules, whereas nonpolar solvents provide superior extraction efficacy for nonpolar compounds. The obtained findings establish a foundation for further explorations on the possible bioactivity of *Psidium guajava* fruit extracts. The subsequent step of the research entailed conducting a thorough phytochemical examination of the crude extracts derived from the fruit of *Psidium guajava*. The objective of this investigation was to provide insight into the occurrence of diverse phytochemical substances across distinct fractions.

A comprehensive screening was conducted on a set of ten distinct classes of compounds, including alkaloids, phenols, flavonoids, saponins, phytosterols and triterpenes, tannins, carbohydrates, proteins, carboxylic acids, and coumarins. This screening was performed on five distinct fractions, each acquired by the use of the aforementioned solvents. The findings given in Table 2 provide interesting insights into the allocation of these phytochemicals across different fractions. It is worth noting that individual chemicals exhibited a distinct preference for particular fractions, underscoring the need of carefully choosing the appropriate solvent during the extraction procedure. Alkaloids were predominantly detected in the fractions extracted with chloroform and ethanol, but phenols and flavonoids were more abundant in the fractions extracted with methanol and ethanol. The chloroform and ethanol fractions had a higher abundance of saponins, whereas the hexane, chloroform, and ethanol fractions demonstrated a significant concentration of phytosterols and triterpenes. The findings of this study offer significant insights into the potential



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bioactivity of *Psidium guajava* fruit extracts. It is well-established that numerous phytochemicals possess diverse health-promoting qualities. The subsequent analysis of the TLC Bioautography assay provided additional evidence supporting the putative anti-cholinesterase action of *Psidium guajava* ethanolic fruit extract. The study successfully determined the detection limit of galantamine, a widely recognised acetylcholinesterase inhibitor, to be 3 mg ml⁻¹. The ethanolic extract of *Psidium guajava* fruits was analysed using thin-layer chromatography (TLC), which demonstrated the existence of two inhibitory zones, suggesting its potential to inhibit acetylcholinesterase. The presence of inhibitory regions was evident when concentrations of 5 mg ml⁻¹ and 10 mg ml⁻¹ were examined, so offering evidence for the possible bioactivity of the extract in the inhibition of acetylcholinesterase, a crucial element in the intervention of Alzheimer's disease. Moreover, the lack of false positives observed in the experiment highlights the specificity of the extract's inhibitory impact on acetylcholinesterase, which is a crucial discovery with implications for therapeutic interventions targeting Alzheimer's disease.

CONCLUSION

The findings of this research collectively suggest that ethanolic extract derived from *Psidium guajava* fruit demonstrate significant anti-cholinesterase action, rendering them a compelling candidate for further exploration in the context of Alzheimer's disease therapy. The significance of solvent choice in acquiring bioactive compounds is highlighted by the utilisation of the Soxhlet extraction technique and subsequent phytochemical analysis. Notably, the ethanol fraction contains a diverse range of phytochemicals and exhibits the capacity to inhibit acetylcholinesterase demonstrated through TLC Bioautography. These findings present a compelling justification for further investigation into the therapeutic possibilities of *Psidium guajava* in the context of Alzheimer's disease intervention. The aforementioned discoveries present promising opportunities for further investigation and potential therapeutic interventions within the field of neurodegenerative disorders.

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Authors Contributions

All the authors- Kunal Bhattacharya, Atanu Bhattacharjee and Manodeep Chakraborty contributed equally in conceptualization, literature review, experimental work, data curation, manuscript drafting and manuscript review. All authors read and approved the manuscript before communication to the journal.

Conflict of Interests

The authors have no conflict of interest.

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Table 1. Percentage yield on using different solvents.

Sl. No	Solvents Used	Extract Weight (mg)	% Yield
1	Hexane	1398	1.4
2	Ethyl Acetate	1923.3	1.9
3	Chloroform	1047.7	1.0
4	Methanol	10657.7	10.7
5	Ethanol	16582.0	16.6



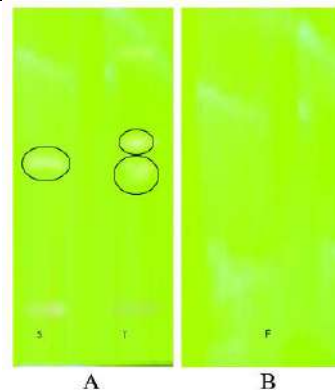
Kunal Bhattacharya *et al.*,Table 2. Phytochemical screening of *Psidium guajava* fractions.

Compounds	Hexane fraction	Chloroform fraction	Ethyl acetate fraction	Methanol fraction	Ethanol fraction
Alkaloids	-	+++	+	-	++
Phenols	-	+	+	++	+
Flavonoids	-	+	+	++	+++
Saponins	+	++	-	-	+
Phytosterols and Triterpene	+++	+++	++	-	+++
Tannins	-	++	++	++	+
Carbohydrates	-	-	+	-	++
Proteins	-	-	-	-	-
Carboxylic acid	-	-	-	-	-
Coumarins	-	-	+	-	+

(-) absent; (+) low; (++) average; (+++) high

Figure 1. Aerial parts of *Psidium guajava*.Figure 2. Shade dried of *Psidium guajava* fruits.

Figure 3. Solvents used: Hexane, Ethyl acetate, Chloroform, Methanol and Ethanol from Left to Right.

Figure 4.(A) Acetylcholinesterase inhibitory activity using TLC assay (B) false-positive control plate. (T:Test) ethanolic extract of *Psidium guajava*. (S: Standard) Galantamine. White spots occurring only on plate (A) indicated acetylcholinesterase inhibition



RESEARCH ARTICLE

Preliminary Phytochemical Screening, Quantitative Analysis and Free Radicle Scavenging Activity of Stem of *Cissus quadrangularis* L.

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ABSTRACT

Most tribal people are highly dependent on medicinal plants for their day-to-day public healthcare and veterinary needs. The existence of medicinal plants and the associated knowledge is currently being threatened mainly due to environmental degradation, global warming, and deforestation. Thus, there is an urgent need to document and analyses this knowledge. *Cissus quadrangularis* L. is a perennial plant belonging to the Vitaceae family that has been used by Gujarat locals as a medicinal plant since antiquity. Screening of phytochemicals present in this plant was carried out to examine the presence of various phytochemicals like alkaloids, terpenoids, glycosides, proteins, carbohydrates flavonoids, phenols, tannins, and saponins. Quantitative analysis was also carried out for phenols and flavonoids in the plant, which showed promising results. In addition, antioxidant activity was also examined for the same using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) method. This plant part proved to be good for certain antioxidant activity and can be explored by pharmaceutical and alternative medicine industries.

Keywords: Qualitative analysis, Quantitative analysis, DPPH assay





INTRODUCTION

Medicinal plants are a valuable legacy for humanity; our forefathers used these plants to ensure their health and passed on their knowledge and experiences from generation to generation. This mode of therapy is used by approximately 80% of the world's population (Azaizehet *et al.*, 2003), particularly in developing countries where a modern medical system is not available (Tabutiet *et al.*, 2003). According to the World Health Organization, approximately 80% of the world's 5.2 billion people live in much less developed countries, and these people rely almost entirely on conventional medicine for primary health care. Traditional medicines are the "backbone" of conventional medicine, which means that they are used on a daily basis by over 3.3 billion people in less developed countries (Ahvaziet *et al.*, 2012). Plants' most important bioactive substances are alkaloid, tannins, flavonoids, and phenolic molecules. Understanding the relationship between phytoconstituents and plant bioactivity is critical for the synthesis of substances with unique functions to cure a variety of health problems and chronic diseases (Yadav *et al.*, 2014). Free radical damage is one of the most likely causes of debilitating diseases such as cardiovascular disease, which can manifest as heart attacks, and cancer, which kills millions of people worldwide (Nafiu *et al.*, 2013). Since antiquity, *Cissus quadrangularis* has been used as a medicinal plant and has been used in various Ayurvedic classical medicines to treat broken bones, ligament and tendon injuries, and other ailments (Singh, V. (2017)). It is used as a tonic and analgesic in siddha medicine, and it is thought to help heal broken bones, hence the name *asthisamharaka* (that which prevents the destruction of bones). *C. quadrangularis* has been used for bone fracture by the Assamese and the Garo tribes of Meghalaya and Bangladesh (Upadhyay *et al.*, 2011). This study stated qualitative and quantitative analysis of phytochemicals and antioxidant activity.

MATERIAL AND METHODOLOGY

Collection of Plant Material

Stem of *Cissus quadrangularis* L. were collected from Gandhinagar, Gujarat, India.

Preparation of Plant Extract

Plant samples were oven-dried in the shade, at room temperature then grounded to a fine powder. The plant powders were undergone to a hot extraction in the Soxhlet apparatus, using three solvents in the order of increasing polarity: Hexane, Methanol and Distilled Water. Each extract was obtained after the removal of the solvent by rotary evaporation.

Phytochemical screening of secondary metabolites

Crude extract was dissolved in each solvent to prepare a solution of 1 mg/ml. This solution was used to realize all the phytochemical tests (Harborne, 1998).

Alkaloids

Individually, 1 mg of extract was dissolved in 1 ml each of distilled water, methanol, and chloroform. Then filter the extract with Whatman filter paper. The presence of alkaloids was checked in the filtrates. The Dragendroff's, Hager's test, Mayer's test, Wager's test and Tannic acid tests were the five assays used to determine the presence of the alkaloids.

Carbohydrates

a) Molisch's test: In this test involved adding 1 ml of extract in the test tube and adding side by side dropwise Molisch's reagent. The presence of carbohydrates is indicated by the violet ring.

b) Barfoed's test: This test involved adding 1 ml of extract in the test tube, adding 1 ml of Barfoed's reagent and boiling the mixture for 2 minutes; the presence of carbohydrates is indicated by red precipitates.



**Mayur Prajapati and Nainesh R. Modi****Phenols**

a) Lead Acetate Test: This test involved adding 1 ml of extract in the test tube. Add 0.5ml of lead acetate, white ppt shows presence of phenols.

b) Folin-Coicalteau Reagent test: This test involved adding 1 ml of extract in the test tube 1 ml of folin-Coicalteau Reagent, bluish-green color determines that phenols are present.

Flavonoid

a) Lead acetate test: 1ml liquid extract treated with 1ml 10% lead acetate solution; yellow coloration The presence of flavonoids is indicated by precipitation.

b) H₂SO₄ Test: 1 ml plant extract treated with conc. H₂SO₄; an orange color indicates the presence of flavonoids.

c) Zinc-hydrochloride reduction test: Apinch of zinc dust added into 1ml plant extract and after that conc. HCl was added along the side of the test tube; the Magenta color indicates the presence of flavonoids.

d) Alkaline reagent test: 1 ml of extract was treated with a few drops of dilute NaOH and a few drops of dilute HCL; the presence of flavonoids is indicated by the yellow color turning into a colorless solution.

Glycosides

a) Borntrager's test: In this test involved adding 1 ml of extract in the test tube, adding 2 ml of chloroform shake well and then adding 10% ammonia solution. The presence of glycosides is indicated by the solution turning pink color.

b) Keller-kilani test: 1 ml extract add 1 ml glacial acetic acid also add 2 drops of 2% ferric chloride, then concentrated sulphuric acid was added and observed for the formation of two layers; the upper layer was reddish brown and the lower layer was bluish green indicates that glycosides present.

Protein

a) Millon's test: In this test involved adding 1 ml of extract in the test tube and adding 1 ml of Millon's reagent, the presence of proteins is indicated by the color white ppts.

b) Biuret test: In this test involved adding 1 ml extract in the test tube, adding 0.5ml of 2% , 1 ml of ethanol, and 1 KOH pellets. The presence of protein is indicated by the observed pink color of the ethanolic layer.

Saponin

a) Froth test: In this test involved adding 1 ml of extract in the test tube, adding 5 ml of distilled water, and vigorously shaking the mixture for 5 to 10 minutes, if foam observed it means saponins are present.

Tannins

a) Lead Acetate Test: In this test involved adding 1 ml of extract in the test tube. Add three drops of lead acetate. A creamy gelatinous precipitate indicates the presence of tannins.

b) Ferric chloride test: The sample was first hydrated with water. Water excess was removed with filter paper. Then, three drops of ferric reagent were added to the sample. A grey or black color formation indicates the presence of tannins.

Terpenoids

a) Salkowski test: extract with 2 ml of chloroform then add 3 ml concentrated sulphuric acid; the formation of Reddish-brown color ring was the presence of terpenoids.

b) Copper acetate test: 1 ml filtrate taken with 1-2 drops of acetate solution, if green color precipitates were seen then terpenoids present.

Quantitative determination of secondary metabolites**Determine Total Flavonoid Content**

The aluminum chloride technique was used to measure the presence of flavonoids (Chang *et al.*, 2002). The following ingredients were added to 1 mL of methanolic extract: 0.1ml of 10% aluminum chloride, 0.1ml of 1 M potassium acetate solution, and 5 mL of distilled water. The samples were incubated for 30 minutes at room temperature after





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1/2 hour, and the absorbance at 415 nm was then determined. At a final concentration of 1 mg/mL, the extract samples were assessed.

Determine Total Phenolic Content

The Folin-Ciocalteu technique was used to determine the total phenolic content of the extract (Kaur and Kapoor, 2002). In brief, 1.0 ml of crude extract was thoroughly combined with 0.5 ml of Folin-Ciocalteu reagent for 5 minutes before 1.5 ml of 20% sodium carbonate was added. After 30 minutes of standing time in the dark, the mixture's absorbance at 765 nm was determined.

DPPH Free radical scavenging method used in Antioxidant activity assay.

The Antioxidant activity was tested by the DPPH radical scavenging method in methanol extracts of the stem of *C. quadrangularis*. To evaluate this, the method described by (Germanoet al., 2002) was employed with a few modifications. 4 mg of DPPH or 2,2 diphenyl-1-picrylhydrazyl is taken and dissolved in 100 mL in methanol making it the concentration of 0.04mg/ 1 mL of DPPH solution and stored in a dark area as DPPH is light sensitive. The standard solution of Ascorbic Acid was prepared with 50 mg of standard in 50 mL of the solvent making it the concentration of 1mg/ 1 mL of standard solution. The experiment was carried out in triplicate series to minimize error. The stock solution series is prepared with Ascorbic acid solutions in methanol with concentrations ranging from 25 µL to 125 µL. The scavenging activity is calculated based on the percentage of DPPH radical scavenged (%) with the help of the following formula,

$$\% \text{ Inhibition Activity} = \frac{\text{Absorbance of the blank} - \text{Absorbance of sample}}{\text{Absorbance of blank}} \times 100$$

The values of % I is used to calculate IC₅₀ values which represent the half maximal inhibitory concentration that is a measure of the effectiveness of the substance in inhibiting the specific biological or biochemical function.

RESULT AND DISCUSSION

Results of qualitative analysis of phytochemicals.

Result of Total Flavonoid Content

Result of Total Phenolic Content

Total Phenolic Content for methanol

DISCUSSION

Phytochemicals have pharmacological properties, according to the phytochemical analysis used in this study, many phytochemicals are present in plant extract. Alkaloids, carbohydrates, phenols, flavonoids, glycosides, protein, saponin, tannins, and terpenoids all show positive results in all three extracts. A total of five tests were performed for alkaloids in which hexane extract showed positive results in each test. In methanol extract, except the Wager's test, alkaloids were seen present in all tests whereas aqueous extract gave negative results in Hager's test and Mayer's test, but alkaloids were present in the other three tests. Barfoed's assays for measuring carbohydrates yielded no results, however, Molisch's test revealed that all three extracts contained carbohydrates. All three extracts show positive results for phenol in the lead acetate test as in the Folin–ciocalteu test, only methanolic extract indicated the presence of phenol. Out of four tests, in the H₂SO₄ test and alkaline reagent test all three extracts revealed the presence of flavonoids. All three extracts give negative results in the zinc HCL test. Nonetheless, the hexane extract demonstrated the presence of glycosides in Keller–killani test. Good results were observed in the millon's test while in the biuret test, three extract gives negative results for protein. In the froth test for saponins, methanol and aqueous solutions provided positive results whereas hexane showed negative results. In the lead acetate test for tannins in all extracts, positive results were shown. In the ferric chloride test except hexane both aqueous and methanolic extracts show the presence of tannins. All extracts show positive results in both the Salkowski test and the copper



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acetate test of terpenoids. The total absorbance of flavonoid content in *C. quadrangularis* was 60.05447mg/QE/g of the sample when the TFC test absorbance of 415 nm was performed in methanolic stem extract using a series of 25 to 200 samples. Test series of 100µl to 600µl for methanol and 100 to 500 for aqueous were conducted to determine the total phenolic content for both aqueous and methanolic extract. When evaluated at an absorbance level of 765 nm, *C. quadrangularis* total absorbance in an aqueous extract came out to 31.8µg/gm and in a methanolic extract was 117.0557µg/gm. The DPPH free radical scavenging test series of 25 to 125 showed scavenging activity at 517 nm. The %RSA value of the standard (Ascorbic acid) is 90.96% in 0.125ml solution whereas, in a same concentration, the plant extract shows 64.96 % RSA. Findings were showed as 50% inhibition concentration (IC₅₀) calculated from the regression equation through a graph of concentration against the percentage of inhibition. In this study, the IC₅₀ value of methanolic extract was 54.30 µg/ml.

CONCLUSION

The main goal of the study was to identify the many secondary metabolites present in the stem extract of *Cissus quadrangularis* L., as well as their beneficial functional groups and antioxidant activity. The presence of secondary metabolites raised the possibility of certain therapeutic uses and total content of phenolic and flavonoid showed remarkable results. *Cissus quadrangularis* L. stem extract exhibits DPPH radical scavenging action and by utilizing these useful additives' pharmacological effects necessitates additional study via the use of extraction, purification, separation, and identification processes. The results of this study imply that this plant stem may be a source of natural antioxidants that may be crucial as therapeutic agents in preventing or reducing the progression of aging and age-related oxidative stress-related degenerative illnesses. However, more research is needed on the isolation and characterization of the antioxidant components.

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Table 1: Showing the results of qualitative screening (+ indicates presence and – indicates absence)

Phytochemicals	Test	Results		
		Aqueous	Methanol	Hexane
Alkaloids	Dragendroff's	+	+	+
	Hager's test	-	+	+
	Mayer's test	-	+	+
	Wager's test	+	-	+
	Tannic acid test	+	+	+
Carbohydrates	Molish test	+	+	+
	Barford test	-	-	-
Phenols	Lead acetate test	+	+	+
	Folin – ciocalteu test	-	+	-
Flavonoids	Lead acetate test	-	+	+
	H ₂ SO ₄ test	+	+	+
	Zinc HCL Reduction test	-	-	-
	Alkaline reagent test	+	+	+
Glycosides	Borntrager's test	-	-	-
	Keller-killani test	-	-	+
Protein	Millon's test	-	+	+
	Biuret test	-	-	-
Saponin	Froth test	+	+	-
Tannins	Lead acetate test	+	+	+
	Ferric chloride test	+	+	-
Terpenoids	Salkowski test	+	+	+
	Copper acetate test	+	+	+

Table: 2 Total Flavonoid Content-Absorbance of Standard (Quercetin)

Sr no.	Concµl/l	Absorption	Content (mg/QE/g of sample)
1	25	0.422	60.05447
2	50	0.527	





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3	75	0.738	
4	100	0.907	
5	125	1.075	
6	150	1.215	
7	175	1.426	
8	200	1.641	

Table: 3 Total Phenolic Content-Absorbance for standard (Gallic acid)

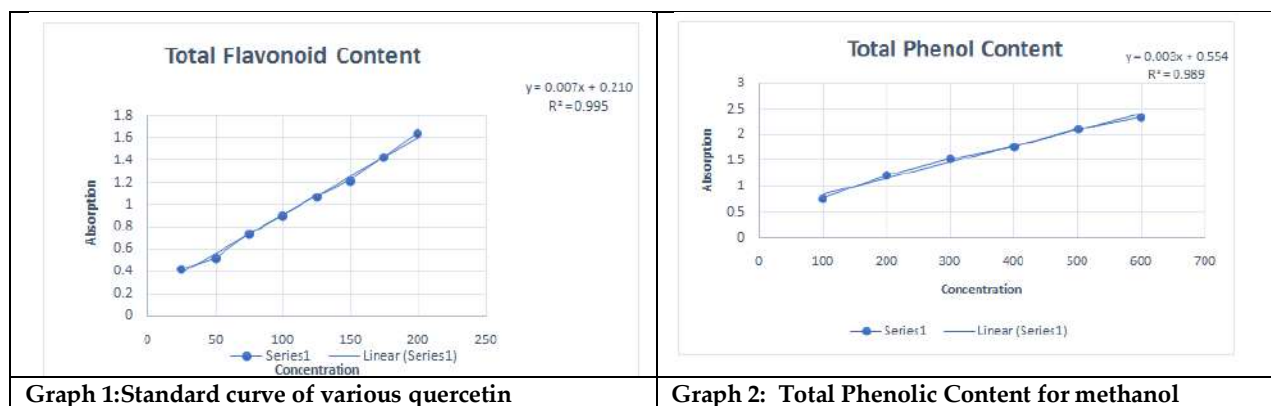
sr no.	Concµl/l	Absorption	Content
1	100	0.778	117.0557µg/gm
2	200	1.227	
3	300	1.545	
4	400	1.769	
5	500	2.121	
6	600	2.351	

Table:4 Total Phenolic Content-Absorbance for standard (Gallic acid)

Sr. no.	Concentration	%OD	Total Content
1	100	1.345	31.8µg/gm
2	200	1.858	
3	300	2.396	
4	400	2.926	
5	500	3.296	

Table:5 Antioxidant activity – Absorbance of standard compound (Ascorbic acid) and Extract

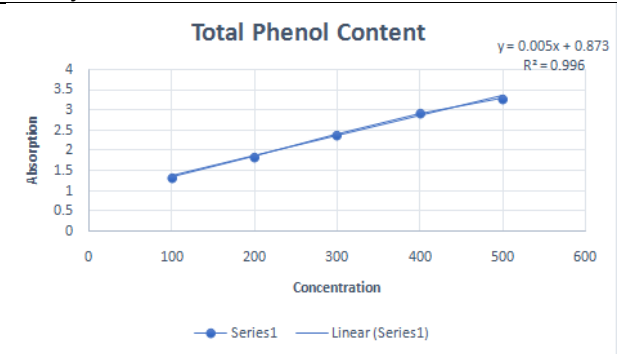
Sr.no.	Concentration (µg/ml)	DPPH Scavenging Activity (%)	
		Methanol	
		Standard	Extract
1	25	25.540±0.248	45.737±0.004
2	50	29.807±0.248	49.166±0.002
3	75	35.324±0.130	52.259±0.001
4	100	37.656±0.883	57.361±0.002
5	125	39.790±0.103	64.96±0.003
			IC-50= 54.30



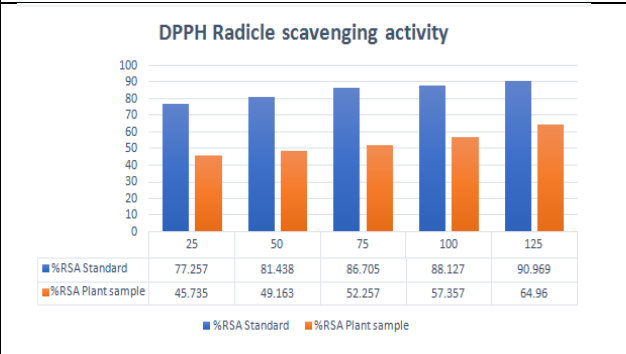


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concentrations (µg/ml) and their corresponding optical density



Graph 3: Total Phenolic Content for aqueous



Graph 4: DPPH scavenging activity of Ascorbic acid and Extract of Cissus quadrangularis





Balancing Legitimate Interests with Data Privacy in Cyber Crime Investigations

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ABSTRACT

The digital age of cybercrime is a real threat to individuals, businesses, and governments worldwide. In response to this growing problem, law enforcement agencies and cyber security professionals have sometimes had to gather or process personal data during cybercrime investigations. This article investigates the complexities of processing actual interest during data privacy regulations and cybercrime inquiries. It discusses the significance of finding a balance between what law enforcement requires and what should be preserved regarding individuals' rights to privacy. The article offers insights into the legal provisions, ethical aspects, and best practices that investigators should observe when seeking justification for proper interest in cyber security. Privacy is a fundamental human right, as enshrined in the Universal Declaration of Human Rights. So, to facilitate the maintenance of data confidentiality, personal data that has no direct connection with what occurs under investigation should be eliminated during proceedings bonded by Legitimate Interest for National Security and Peacekeeping purposes. Data privacy problems can be severe in investigations involving several jurisdictions. Multinational companies and even governments would likely be susceptible to cross-border considerations when addressing such queries that are bound up with data privacy being handled effectively. First and foremost, an organization engaged in an investigation should generally be wary of the relevant data privacy laws to safeguard itself. Such information privacy concerns could arise at different stages in an investigation, more so when data that has personal details involved is going to be collected and even during that investigation whereby such information may need to get processed only for them to be transferred sometimes now and then across borders by bodies who do not have any



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protocols whatsoever. An organization must be aware of its possibly conflicting duties and responsibilities towards the people whose personal data it is dealing with and the power that steers up such an investigation.

Keywords: Balancing Legitimate Interests, Cyber Crime, Data Privacy, E-Commerce, Human Rights.

INTRODUCTION

Due to the rapid increase in cybercrime, there are now significant concerns regarding how law enforcement and cyber security experts should conduct investigations while navigating the complicated world of data protection. The idea of legitimate interest, which offers a legal foundation for processing personal data when the rights of the data subject are balanced against those of the data controller or a third party, is one of the key components in this problem. This article clarifies how legitimate interests may be used in cybercrime investigations while adhering to data privacy laws. In the current digital age, when data is becoming more important to our globalised society, protecting personal privacy is more important than ever. Concurrently, the proliferation of cybercrime and its constantly developing intricacy provide enormous obstacles for both people and institutions. Protecting data privacy rights while balancing the need of efficient cybercrime investigations has grown to be a challenging and urgent problem. In order to traverse this complex terrain and evaluate the effectiveness of protecting data privacy during cybercrime investigations, this paper sets out to investigate the function of Data Protection Impact Assessments (DPIAs). The breadth and extent of cybercrime, which includes everything from identity theft and online fraud to hacking and data breaches, has increased. Law enforcement authorities and commercial enterprises must enter the digital sphere to combat these dangers, which often requires gathering, processing, and analysing enormous volumes of data. Although these initiatives are essential for prosecuting hackers and lessening the harm they have caused, they inevitably trample on the delicate territory of personal data privacy (Duyne et al., 2017).

A number of data protection legislation and regulations, like the California Consumer Privacy Act and the General Data Protection Regulation (GDPR) of the European Union, have been passed globally in response to the growing importance of data privacy (CCPA). These laws safeguard people's rights and liberties by requiring authorities and companies that handle personal data to abide by strict data protection guidelines. The Data Protection Impact Assessment is one of the most important instruments provided by these legislation to balance the necessity for investigations with the protection of personal data (DPIA). DPIAs are methodical evaluations created to identify and reduce privacy threats related to handling personal information. Though DPIAs are generally acknowledged as crucial elements of privacy compliance, there is still much to learn about their efficiency and applicability in the context of cybercrime investigations. By examining the use of DPIAs in cybercrime investigations, this paper seeks to close this disparity. We will analyse the possibility of DPIAs as a protecting mechanism in digital investigations, as well as the theoretical underpinnings of data privacy and their complexities. Through empirical research and real-world case studies, we will assess how DPIAs affect data privacy while conducting cybercrime investigations. We will also talk about policy implications and ethical issues, which will help to clarify the wider social ramifications of our research. In a time when cyber dangers loom and data-driven technologies influence our daily lives, it is critical to establish a careful balance between enforcing the law effectively and protecting individual privacy (Lallie et al., 2021). The goal of this essay is to examine the intricacies of this equilibrium and evaluate how useful DPIAs are for achieving justice while preserving the rights of data privacy.

Hypothesis

"Adopting strong legislative frameworks and technology tools may help maintain a balance between the legitimate objectives of law enforcement agencies in carrying out efficient cybercrime investigations and protecting data privacy rights.."



**Prabhu Rajasekar and Vezhaventhan****Research Aim**

In the context of cybercrime investigations, this study intends to investigate the processes and techniques used to strike a balance between legitimate interests and data privacy. Additionally, it seeks to identify best practises and tactics for achieving this balance (Ogriseg, 2017).

Research Questions

1. What are the main obstacles and conflicts in striking a balance between data privacy and legitimate interests in cybercrime investigations?
2. Which international legal frameworks and legislation protect data privacy and regulate data gathering and processing during cybercrime investigations?
3. Which technology instruments and investigative techniques are used in cybercrime investigations to assist allay privacy concerns?
4. In the context of cybercrime investigations, how are legitimate interests and data privacy balanced across many nations and organisations?
5. What ethical issues could arise when weighing these interests, and how might they affect the way decisions are made?

Research Objectives

1. To list and evaluate the primary difficulties and conflicts that arise when trying to strike a balance between data privacy and legitimate interests in cybercrime investigations (Tao et al., 2019).
2. to examine and evaluate the legal and regulatory frameworks that control the gathering, handling, and storage of data while conducting investigations into cybercrime.
3. In order to preserve data privacy and accomplish investigative objectives, it is necessary to look into and assess the technical instruments and tactics used in cybercrime investigations.
4. to carry out a comparative study of the methods used by other nations and organisations to solve these problems.
5. to examine the moral issues related to legitimate interests and data privacy in the context of cybercrime investigations and to provide suggestions for moral decision-making.

LITERATURE REVIEW

In the context of cybercrime investigations, striking a balance between legitimate interests and data protection is a complex task (De Hert et al., 2018). This survey of the literature looks at the important problems, legal frameworks, technical advancements, and moral dilemmas related to this important subject. The privacy of data is greatly impacted by legal and regulatory frameworks when it comes to criminal investigations. One important piece of legislation that regulates the processing of personal data is the General Data Protection Regulation (GDPR) in the European Union. It highlights the need of proportionality and a legal foundation for data processing (GDPR Article 6). Guidelines for evaluating the legality of data processing based on legitimate interests are provided by the European Data Protection Board (EDPB) (EDPB Guidelines on Legitimate Interests). There are several difficulties in striking a balance between data privacy and legitimate interests. Important concerns include the possible abuse of surveillance technologies and acquired data, conflicts between security and privacy, and disparities in international laws and jurisdictions (Veale et al., 2018).

DATA COLLECTION

Information from a sample of participants was gathered as part of the data collection process in order to look into their involvement in e-commerce, familiarity with cybercrime concepts, firsthand experiences with cybercrime incidents, opinions about the ability of law enforcement to handle cybercrime cases, knowledge of where to report cybercrime incidents, use of digital evidence collection tools, and adoption of two-factor authentication for online accounts. 1455 people in all, representing a varied population, were surveyed, and quantitative data was gathered



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via the administration of standardised questionnaires (Sviatun et al., 2021). Statistical methods, such as Pearson correlation and independent samples t-tests, were used to examine possible associations and distinctions between the variables based on the replies provided by the participants. By offering insightful information on the relationship between cyber security awareness and e-commerce activity, the research hoped to further knowledge of people's viewpoints and behaviours in the digital sphere.

METHODOLOGY

The study used a quantitative research technique to look at the connections and distinctions between different aspects of cyber security awareness and e-commerce involvement. 1455 people completed a cross-sectional survey, and data were gathered from them. Important factors like the frequency of e-commerce activities, knowledge of cybercrime concepts, firsthand experiences with cybercrime incidents, opinions about the competence of law enforcement, knowledge of reporting channels, use of digital evidence collection tools, and adoption of two-factor authentication were all covered in a structured questionnaire. On a Likert scale, participants answered the questions and supplied demographic data (Cavelty& Egloff, 2019). Following that, the quantitative data were statistically analysed using independent samples t-tests to investigate any group differences and Pearson correlation coefficients to look at correlations between variables. The research sought to provide a thorough grasp of people's attitudes and behaviours in the digital sphere, illuminating from a quantitative standpoint the relationship between e-commerce activity and cyber security awareness. The theoretical framework emphasises following the law and recognising legitimate interests, integrating legal elements via GDPR and Legal Positivism.

The proportionality theory directs how privacy invasion is investigated in various legal contexts. In cybercrime investigations, virtue ethics and rights-based ethics are important factors to take into account. Technology and privacy are addressed by Privacy by Design, Surveillance Theory, and the DPIA Framework, which provides proactive data protection (Bennett, 2018). International Relations and Comparative Law Theories provide light on the difficulties associated with cross-border data exchange, such as sovereignty and jurisdiction. Decisions involving the balance of interests are aided by risk-benefit analysis, institutional and organisational theories, institutional theory, resource dependency theory, and public choice theory. Technology Adoption Theories, such as TAM, provide light on law enforcement's embrace of privacy-enhancing technologies. In cybercrime investigations, this integrated framework provides a thorough method for managing the challenges of data privacy. This theoretical framework guides your study on balancing legitimate interests with data privacy in cybercrime investigations by including viewpoints from the legal, ethical, technical, and organisational domains. It offers a thorough, interdisciplinary method for comprehending and resolving this difficult problem.

Research Design

Quantitative Approach

Using quantitative analysis in the surveyed data, statistical analysis is employed to identify the relationship between the variables.

Sampling

Purposive Sampling

Purposive sampling was used to select participants with expertise in the subject matter, such as legal experts, law enforcement officers, and privacy advocates.

Random Sampling

For surveys and questionnaires, random sampling has been employed to ensure a representative sample of respondents.



**Prabhu Rajasekar and Vezhaventhan****Data Protection Impact Assessments (DPIAs)**

The process of conducting an inquiry for the purpose of managing data is outlined in a data protection impact assessment, which also addresses the importance of data privacy protection. It will also cover the special difficulties and advantages of using DPIAs in cybercrime investigations. An essential procedure for assessing the advantages and hazards related to data protection for a specific data processing activity is a Data Protection Impact Assessment (DPIA), also known as a Privacy Impact Assessment (PIA). Doing a DPIA is crucial to ensuring compliance with data protection laws, such as the General Data Protection Regulation, in cybercrime investigations when legitimate interest serves as the legal justification for data processing (GDPR). To conduct a DPIA for a valid interest in a cybercrime investigation, follow these steps:

1. Clearly Define the Scope and Goals: To start, specify the goals and parameters of the cybercrime investigation. Indicate the goals you have in mind, the data you want to handle, and the legitimate interests supporting this processing.
2. Identify Data Processing Activities: Make a list of all the data processing tasks that will be carried out while the inquiry is underway. This include gathering, storing, analysing, exchanging, and maybe transferring data.
3. Determine Proportionality and Necessity: Determine if data processing is appropriate and required given the objectives of the study. Think about if less invasive methods may accomplish the same goals.
4. Identify Data Subjects: Determine which people's information will be used in the course of the inquiry. Suspects, victims, witnesses, and anyone whose information is pertinent may fall under this category.
5. Examine Legitimate Interest: Examine carefully why legitimate interest is the best suitable legal justification for processing data. Determine if the rights and interests of the data subjects are superseded by the legitimate interests of the data controller or third party. The nature of the study and any possible damage that may be avoided or lessened should be taken into account in this examination.
6. Privacy Threats and Mitigations: Determine and evaluate any risks to the freedoms and rights to privacy of data subjects. Take into account the technological and organisational steps that may be taken to reduce these risks. To preserve privacy, you may, for instance, encrypt or pseudonymize data.
7. Speak with Officers of Data Protection: Communicate with the Data Protection Officer (DPO) of your company or, if required by legislation, the appropriate data protection authorities. Since they are authorities on data protection and may provide direction on compliance, get their opinion and advise on the DPIA.
8. Document Everything: Make sure that every step of the DPIA process—including evaluations, choices, and mitigations—is well documented. This paperwork demonstrates the dedication of your company to data protection compliance.
9. Transparency and Communication: As required by data protection legislation, provide transparency by informing data subjects of the reason and goal of data processing. Gaining the confidence of the people whose data is being handled may be facilitated by transparency.
10. Ongoing Review and Monitoring: Throughout the inquiry, keep an eye on the data processing operations and update the DPIA if anything changes. Maintaining compliance and making adjustments for new knowledge are critical.
11. Completion and Reporting: In compliance with the law, as soon as the DPIA is finished, provide a summary of the assessment to all relevant parties, including legal counsel, law enforcement, and data protection authorities.
12. Continuous Improvement: In future investigations, use the DPIA's findings to constantly enhance data protection procedures. Applying the lessons learnt helps improve compliance and reduce risks.

You may balance the demands of law enforcement with people' privacy rights by performing a thorough DPIA in the context of a cybercrime investigation. This will guarantee that legitimate interest is properly justified and that data protection standards are respected throughout the process.





RESULT AND INTERPRETATION

Correlation

In order to determine the relationships between the different factors that influence people's engagement with e-commerce activities, knowledge of cybercrime concepts, firsthand experiences with cybercrime incidents, opinions about the ability of law enforcement to handle cybercrime cases, knowledge of channels for reporting cybercrime incidents, use of digital evidence collection tools, adoption of two-factor authentication for online accounts, age, gender, educational background, and current occupation, the study conducted a correlation analysis. Significant relationships between a few of these factors were found in the data. Interestingly, there was a positive association found between the frequency of e-commerce activity and knowledge of cybercrime ideas, indicating that those who engage in e-commerce more often had a greater understanding of cybercrime concepts. Younger participants tended to have a more critical view of law enforcement's performance in this sector, as seen by the negative association that was found between age and the assessment of law enforcement's competence in managing cybercrime cases. It's crucial to remember that correlation does not indicate causation, and further investigation is required to determine the underlying causes of these interactions. 1455 people made up the study's sample, and a 2-tailed significance level of 0.05 was used. These results provide important new information on the interactions between e-commerce and people's knowledge of cyber security.

Independent sample T-test

To determine whether there were any differences between the groups regarding participation in e-commerce, knowledge of cybercrime concepts, firsthand experiences with cybercrime incidents, opinions about the ability of law enforcement to handle cybercrime cases, knowledge of channels for reporting cybercrime incidents, use of digital evidence collection tools, and adoption of two-factor authentication for online accounts, independent samples t-tests were performed. To ascertain if the assumption of equal variances was satisfied, Levene's test for equality of variances was used. The results of the t-test showed that there were no significant differences between groups when equal variances were assumed. On the other hand, no significant differences were found by the t-tests when equal variances were ignored. For example, whether or not equal variances were assumed, the findings for the case of engaging in e-commerce activities revealed that the mean difference was not statistically significant ($t(663) = -0.065$, $p = 0.948$; $t(64.379) = -0.016$, $p = 0.950$). Consistent results were noted for the other variables, suggesting that there were no notable differences between the groups. These findings provide light on the comparability of different aspects among the selected people and demonstrate that there are no significant differences depending on the variables that were evaluated.

Case Studies

This section will include case studies and real-world situations. These examples will show how DPIAs have been used, or might have been used, to safeguard data privacy in cybercrime investigations. Examining these instances will offer useful information about how well DPIAs protect data privacy. Provide case studies or illustrations of actual cybercrime investigations. Examine how DPIAs were or may have been used in these situations to safeguard the privacy of the data. Case studies that use data for investigation include real-world examples of how information is gathered, handled, and examined to solve different types of crimes and take care of security issues. Here are a few case examples from various fields:

The Target Data Breach

Context: In 2013, the retail behemoth Target had a significant data breach that exposed the credit card details of more than 40 million consumers.

Data Usage: To investigate the incident, law enforcement organisations and cybersecurity specialists worked together. To determine the extent and source of the intrusion, they gathered and examined malware signatures, network activity, and log data.



**Prabhu Rajasekar and Vezhaventhan****Result**

The investigation's efforts paid off when the accountable hackers were located and apprehended, proving that data can be used to track down and prosecute cybercriminals.

Financial Fraud Detection

Case Study The Ponzi Scheme of Bernard Madoff

Background Bernard Madoff masterminded one of the most notorious Ponzi scams in recorded history, swindling billions of dollars from unsuspecting investors.

Data Usage Bank records, investment statements, trade logs, and other financial transaction data were among the many pieces of information that financial investigators gathered and examined. This information was essential to identifying the fraudulent scam.

Result of the investigation Madoff was apprehended, found guilty, and sentenced to a long period of imprisonment. The case emphasises how crucial data is in revealing financial malfeasance.

Counterterrorism

Case Study Bombing at the Boston Marathon

Background A terrorist assault that targeted the Boston Marathon in 2013 claimed many lives.

Data Usage In order to identify the suspects and follow their whereabouts, law enforcement authorities gathered and examined a broad variety of data, including social media posts, mobile phone records, surveillance video, and online communications.

Result By identifying and apprehending the individuals, the investigation demonstrated how many data sources may be used to solve complex crimes.

Missing Persons Investigation

Amber Alert System Case Study

Background In situations of kidnapping, the Amber Alert system locates missing children.

Data Usage To send notifications to law enforcement, the public, and media sources, the system utilises the child's description, facts about the suspect, the position of the car, and its geographic coordinates. Rapid distribution and data exchange are essential.

Result Many missing children have been found thanks to the system, highlighting the value of quick data exchange and public participation in the investigation of missing people situations.

Drug Trafficking Investigation

Case Study Odessa Operation

Background Operation Odessa included a worldwide network of criminals and was an international drug trafficking investigation.

Data Usage A lot of information on people, money transfers, and international activity was gathered and examined by law enforcement authorities. This includes communication intercepts, financial records, and surveillance data.

Result By breaking up a significant drug trafficking network and leading to several arrests and convictions, the investigation showed how data can be used to combat organised crime. These case studies highlight the wide spectrum of data-dependent investigations, including those involving financial crime, cybersecurity, counterterrorism, and situations involving missing people. Data is essential for solving crimes, locating suspects, and prosecuting offenders; this emphasises the need of technological know-how and moral concerns in data-driven investigations.

Evaluation of Data Privacy

With an emphasis on the implications of DPIAs, this section will provide a thorough assessment of data privacy during cybercrime investigations. The impact of DPIAs on the results of investigations will be evaluated by a comprehensive statistical analysis and the presentation of empirical data, if available. Examine how well DPIAs



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protect data privacy while conducting cybercrime investigations. Provide actual data and, if relevant, statistical analysis. Talk about how DPIAs affect the findings of investigations.

Ethical Considerations

It is a difficult ethical task to strike a balance between the necessity for efficient cybercrime investigations and protecting individual privacy. The ethical issues surrounding DPIAs in this particular setting will be covered in this section, along with the trade-offs and moral conundrums that organisations and law enforcement must resolve. Discuss the moral issues involved in striking a balance between the necessity to investigate cybercrimes and data privacy.

Recommendations and Policy Implications

This section will provide useful suggestions for enhancing the use of DPIAs in cybercrime investigations based on the study results. It will also go over possible improvements or modifications to policies that are required to better safeguard the rights to data privacy while maintaining efficient law enforcement. Make suggestions on how to enhance the use of DPIAs in cybercrime investigations.

Potential policy changes or enhancements to protect data privacy

When conducting investigations into cybercrimes, data privacy is crucial. Investigating and combating cybercrimes is crucial for the safety of people, businesses, and society as a whole, but it's also critical to uphold people's right to privacy and adhere to the law and ethical standards. Several crucial elements of data privacy in cybercrime investigations are as follows:

1. Legal Frameworks: In order to access and gather data during an investigation, investigators must abide by all applicable legal frameworks and get the necessary authority, such as search warrants or court orders.
2. Laws and regulations pertaining to data privacy and law enforcement access to data differ throughout nations. Investigators are required to be aware of and abide by these laws.
3. Data Minimization: Only gather information that is specifically needed for the inquiry. Refrain from gathering too much or unnecessary information on people who aren't connected to the cybercrime.
4. Permission: Before accessing someone's data or equipment for the purpose of an inquiry, try to get their informed consent. However, in certain legal situations, consent could not be necessary.
5. Respect the usage of encryption in data protection. Without the right licence or legal support, trying to crack encryption could be against the law in terms of privacy.
6. Anonymization and pseudonymization: To safeguard the identity of those participating in an investigation, particularly if their participation is accidental and unconnected to cybercrime, investigators should take into account data anonymization and pseudonymization procedures.
7. Safe Storage and Transmission: To avoid unwanted access and data breaches, make sure that any information gathered during an inquiry is safely kept and communicated.
8. Data Retention: Define precise guidelines for the storage and removal of data. The data need to be safely and permanently erased when an inquiry is over and it is no longer required.
9. Transparency: Be open and honest with the people whose data is being gathered. Tell them about the investigation's methodology and the intended use of their data.
10. Chain of Custody: To guarantee the integrity and admissibility of all evidence gathered during an inquiry in court, maintain a safe chain of custody.
11. Working together with IT companies: Collaborate collaboratively with service providers and tech firms to secure information pertinent to the inquiry while upholding user privacy. Many businesses handle these kinds of demands via rules and legal departments.
12. International Aspects: Cybercrime frequently crosses national boundaries. Cross-border investigators handling data privacy problems may have to negotiate multinational legal frameworks and agreements.



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13. Moral Aspects to Take into Account: Think about the ethical ramifications of data gathering and usage during investigations in addition to the legal duties. Strive to strike a balance between upholding people's right to privacy and the pursuit of justice.

In conclusion, although conducting cybercrime investigations within a framework that respects and protects people's right to privacy is necessary, it is also critical for sustaining cyber security and public safety. To maintain a moral and legal attitude to their job, investigators should keep up with changing privacy legislation and best practises.

Data Protection Impact Assessment to govern data Privacy during cybercrime investigation

When managing data privacy during cybercrime investigations, a Data Protection Impact Assessment (DPIA) is an invaluable resource, particularly when handling sensitive personal data. Organizations, especially law enforcement agencies, may evaluate and reduce the risks associated with processing personal data by using a systematic procedure called a DPIA. Using a DPIA to protect data privacy during cybercrime investigations may be done as follows:

1. Determine Whether a DPIA Is Necessary: Find out whether processing personal data that might violate people's privacy rights is a part of the cybercrime investigation. In such case, start a DPIA.
2. Describe the Purpose: Give a precise description of the DPIA's purview, including the types of data that will be processed, their particular goals, and the length of time that the data will be retained.
3. Data Mapping and Evaluation: All personal information gathered, used, or accessed throughout the inquiry should be identified and recorded. This covers information gathered from witnesses, victims, and suspects.
4. Analyze the possible privacy hazards that might arise from processing personal data.
5. Risk assessment: Determine the threats to the liberties and rights of data subjects. Think about things like data sensitivity, data volume, re-identification possibilities, and probability and degree of damage.
6. Implement mitigation strategies to lessen the hazards that have been identified. Pseudonymization, access restrictions, encryption, and other organisational and technological security measures may be examples of this.
7. Examine whether you can use data reduction to reduce the quantity of personal information that is gathered.
8. Consultation: To get feedback and resolve issues, consult with relevant parties such as data protection authorities, attorneys, and people whose data may be processed.
9. Documentation: Keep thorough records of the whole DPIA process, including the assessment, mitigation strategies, and conclusions from the consultations.
10. Review and Update: Throughout the investigation, be sure to periodically review and update the DPIA, particularly if the scope or kind of data processing changes.
11. Designing for Privacy Take privacy into account while creating and using investigation instruments and procedures. This involves making certain that only personal information is gathered and sufficiently safeguarded.
12. Transparency: If someone's data is being acquired, be open and honest with them about the data processing procedures involved in the inquiry. Clearly and easily clearly explain data management procedures.
13. Legal Compliance: Verify that all applicable data protection rules and regulations are complied with by the DPIA and the investigation. Obtain any required legal authorizations, such as court orders or search warrants.
14. Awareness and Training: Educate investigators and other investigation participants on data privacy principles and their roles in safeguarding personal information.
15. Accountability: Clearly define who is responsible for data protection within the investigating team and make sure that each person's rights are respected at all times.

Law enforcement organisations may achieve a balance between protecting people's right to privacy and carrying out efficient cybercrime investigations by performing a DPIA. As required by data protection laws, it aids in ensuring that data processing is legitimate, equitable, transparent, and responsible.



**Prabhu Rajasekar and Vezhaventhan****Protocols to follow while using data for investigation purposes:**

Managing data privacy throughout an investigation is crucial to ensuring that the inquiry is carried out within legal bounds and that people's rights and privacy are protected. The following procedures outline how to manage data privacy while using data for research:

1. **Justification and Legal Framework:** Make sure your data processing has a sound legal foundation. Legitimate interest, permission, legal duty, and contract performance are typical basis for inquiries. Learn about applicable data protection legislation, such as the UK's Data Protection Act and the European Union's General Data Protection Regulation (GDPR).
2. **Data Minimization:** Only gather the information required to complete the study. Steer clear of gathering too much or unnecessary information.
3. **When feasible, use anonymization or pseudonymization procedures to safeguard the identity of data subjects.**
4. **Transparency:** Tell individuals who provide data about how and why their data is processed. Transparency promotes compliance with data protection laws and fosters confidence.
5. **Security Procedures:** Put robust security mechanisms in place to safeguard gathered data. To stop data breaches, use access restrictions, safe storage, and encryption.
6. **Update and patch systems and software often to reduce vulnerabilities.**
7. **Data Retention and Deletion:** Clearly define the duration for which data will be retained, as well as the conditions under which it will be deleted when it is no longer required for the inquiry.
8. **Review and remove data that is no longer needed for the inquiry on a regular basis.**
9. **Permission and Consent Withdrawal:** Make sure that consent is freely provided, specific, informed, and reversible at any moment when using it as the legal foundation for processing data.
10. **Immediately stop processing data subjects' information when they give their permission to be withdrawn.**
11. **Data Sharing:** Make that the recipients of any data sharing, such as law enforcement or third-party service providers, abide by security and data protection laws.
12. **Cross-Border Data Transfer:** Adhere to international data transfer protocols like Standard Contractual Clauses (SCCs) or Binding Corporate Rules when moving data across borders, especially outside the European Economic Area (EEA) (BCRs).
13. **Impact Assessment on Data Protection (DPIA):** Processing personal data involves significant dangers to people's rights and freedoms while conducting a DPIA. Potential hazards to data subjects are identified and mitigated with the use of this evaluation.
14. **Rights of Data Subjects:** Immediately reply to inquiries from data subjects. Among other rights, people have the ability to view, edit, and remove their data.
15. **Frequent Reviews and Audits:** Make the required adjustments and conduct regular audits of data protection procedures to guarantee adherence to shifting laws and emerging risks.
16. **Training and Awareness:** Ensure that all investigative staff members are aware of the value of data protection and their responsibilities to uphold privacy by offering training and awareness programmes.
17. **Data Breach Response:** Create a convincing and well-defined plan of action in the event of a data breach, as required by data protection legislation. When there is a breach, quickly notify the appropriate authorities and the impacted data subjects.

Investigators may strike a compromise between safeguarding people's right to privacy and their need for access to data by taking the following actions. To protect data privacy over the course of the investigation, it is essential to cultivate a culture of ethical and responsible data management within investigative teams.

LIMITATIONS

The research may only cover a few pertinent subtopics within this broad issue, given its main emphasis is on how to reconcile legitimate interests and data protection in cybercrime investigations. Because the study mostly uses publicly accessible data and case studies, it may be limited in its depth of analysis by the need for these sources to be more thorough and current. Laws pertaining to cybercrime and privacy restrictions differ across states. These



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variances must be thoroughly addressed in the research, since this may have an impact on how broadly applicable the conclusions are.

Findings

According to the report, there is a serious tension between protecting individual data privacy in cybercrime investigations and law enforcement's legitimate objectives. It is clear that upholding the rule of law and individual rights requires a balanced strategy that takes into account both legitimate interests and data privacy. The results highlight how crucial it is to modify legislative frameworks and investigation techniques in order to stay up to date with emerging technologies and the changing panorama of cyber threats.

Recommendations

In order to provide uniform guidelines for striking a balance between legitimate interests and data privacy, policymakers should endeavour to harmonise international legal frameworks. Law enforcement organizations must to provide clear procedures for monitoring and accountability along with transparency on the ways in which they gather and handle data. To avoid possible abuse, governments should think about tightening regulation and monitoring of surveillance technology employed in cybercrime investigations.

Suggestions

Enhanced Data Encryption: Promoting strong encryption techniques may assist safeguard people's private information while enabling law enforcement to get the information they want with the right kind of legal permission. Public Awareness Campaigns: To inform people about their digital rights and how their data may be used in criminal investigations, governments and organisations may conduct public awareness campaigns.

Future Research

Future studies should concentrate on how new technologies, such artificial intelligence (AI) and quantum computing, affect the delicate balance between data privacy and justifiable interests in criminal investigations. Comparative analyses of the legal systems and customs of other nations might provide important insights into workable strategies for striking a balance between these interests.

CONCLUSION

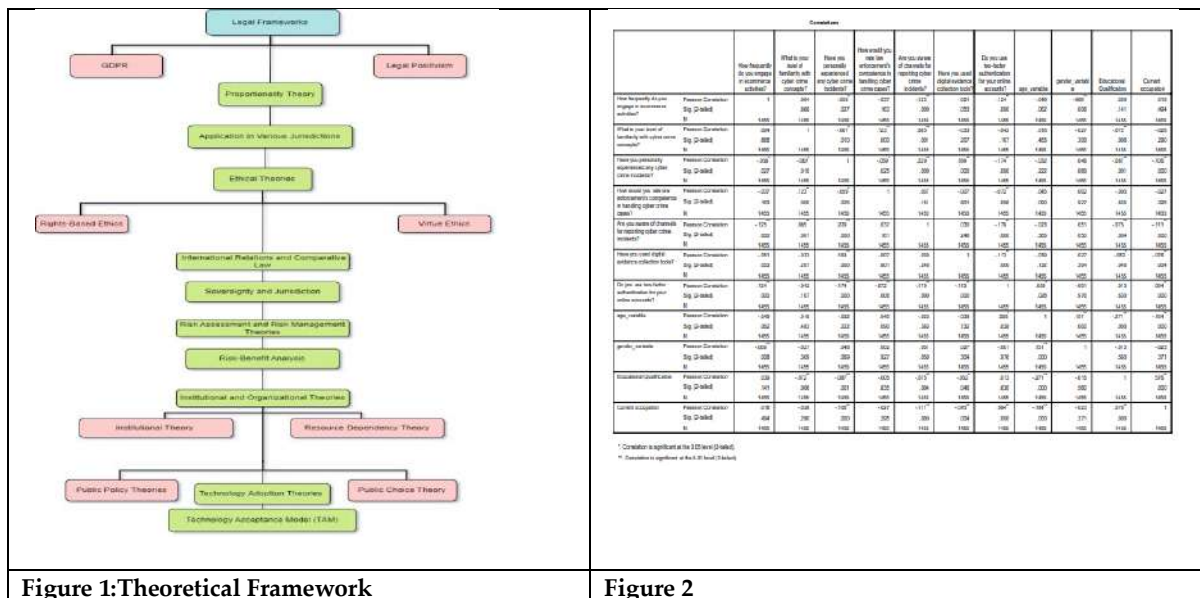
To sum up, the quantitative examination of the gathered information provided several noteworthy revelations on the correlations and differences between elements associated with e-commerce participation and cyber security knowledge (Mantelero, 2017). The research discovered a positive relationship between the frequency of e-commerce activity and knowledge of cybercrime ideas, indicating that those who frequently engage in e-commerce are more likely to be knowledgeable about cyber security risks. Furthermore, there was a negative correlation found between age and the assessment of law enforcement competence in managing cybercrime cases, suggesting that younger participants had a more pessimistic outlook on the efficacy of law enforcement in this area. The e-commerce behaviour and cybersecurity-related characteristics did not show any significant differences between the groups according to the independent samples t-tests. In summary, the results furnish significant quantitative data that helps comprehend the complex relationships between people's online behaviours and their knowledge of cyber security principles. This lays the groundwork for further investigations and real-world applications in the field of digital security.





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Correlations												
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How far do you think the law is being followed?	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	1			
How far do you think the law is being followed?	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	1		
How far do you think the law is being followed?	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	1	
How far do you think the law is being followed?	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	1

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).





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Independent Samples Test									
		Levene's Test for Equality of Variances		t-Test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
How frequently do you engage in e-commerce activities?	Equal variances assumed	3.882	.081	.865	888	.389	-.174	.248	-.665 .317
	Equal variances not assumed			-.862	84.379	.392	-.174	.260	-.693 .345
What is your level of familiarity with cyber crime concepts?	Equal variances assumed	.685	.457	-.889	888	.373	-.129	.188	-.441 .217
	Equal variances not assumed			-.887	84.382	.374	-.129	.179	-.434 .211
Have you personally experienced any cyber crime incidents?	Equal variances assumed	3.086	.079	1.540	888	.123	.118	.087	-.054 .289
	Equal variances not assumed			1.546	82.216	.128	.118	.103	-.088 .323
How would you rate an individual's competence in handling cyber crime issues?	Equal variances assumed	.773	.381	-.420	888	.678	-.040	.112	-.264 .224
	Equal variances not assumed			-.420	84.382	.680	-.040	.106	-.281 .201
Are you aware of strategies for identifying cyber crime incidents?	Equal variances assumed	2.280	.131	.485	888	.627	.072	.140	-.200 .344
	Equal variances not assumed			.511	84.382	.611	.072	.141	-.210 .354
Have you used digital evidence collection tools?	Equal variances assumed	2.286	.130	2.180	888	.034	.280	.084	.114 .446
	Equal variances not assumed			1.670	82.016	.100	.280	.107	-.111 .671
Do you use technical support tools to your online accounts?	Equal variances assumed	.418	.518	1.227	888	.217	.264	.214	-.155 .684
	Equal variances not assumed			1.219	87.372	.262	.264	.200	-.156 .684

Figure 3





A Study on HR Analytics and Challenges with Special Reference to IT Sector

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ABSTRACT

Analytics for human resources (HR) have become a critical instrument in contemporary organisational management, transforming the way companies see and use their personnel. An overview of HR analytics, including its importance, methods, and possible uses in human resource management, is given in this abstract. The process of HR analytics involves gathering information from a variety of sources, such as external data sources, employee surveys, performance reviews, HRIS (Human Resource Information Systems), and recruiting platforms. HR professionals may find patterns, trends, and correlations in data by using advanced analytics tools and methods like predictive modelling, machine learning, and data visualisation. This allows them to make data-driven choices that support company goals and objectives. We will talk about the difficulties with workforce analytics in five different firms in this article.

Keywords: HR Analytics, HR Data, Human Resource Information Systems, HR Professionals, Workforce Diversity.

INTRODUCTION

HR analytics has many different and extensive uses. HR analytics provides practical insights that optimise labour allocation, boost employee engagement, and anticipate staff turnover—all of which contribute to corporate performance and competitive advantage. Additionally, HR analytics promotes a culture of innovation and





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continuous development by empowering businesses to proactively address issues like workforce diversity, skill gaps, and talent shortages.

WHAT IS HR ANALYTICS



HR has evolved from a transactional role to a strategic partner in corporate decision-making thanks to HR analytics, which marks a paradigm change in how businesses manage human capital. Organizations may realise the full potential of their workforce, promote sustainable development, and keep a competitive advantage in the fast-paced business world of today by using data and analytics. The field of human resource (HR) analytics has had a notable surge in interest in recent times due to the growing recognition among companies of the importance of data-driven decision-making in workforce management. HR analytics may be quite beneficial, but putting it into practise might be difficult. The important obstacles that businesses must overcome in order to successfully use HR analytics are examined in this overview of the literature.

LITERATURE REVIEW

Ensuring the availability and quality of data is one of the main issues in HR analytics. Because HR data is often spread across several systems, standardisation and integration are challenging. Decision-making processes are hampered by the inability to guarantee the validity and dependability of analytics insights without accurate, full, and current data. Concerns about data security and privacy pose serious obstacles to HR analytics projects. Employee data must be managed with the highest confidentiality and in accordance with data protection laws, such as GDPR and HIPAA. This includes sensitive information like performance reviews and remuneration details. One of the biggest obstacles to implementing data-driven HR initiatives for firms is the shortage of individuals with HR analytics experience. To successfully use analytics tools and analyse information, HR professionals need to be proficient in technology, have a solid understanding of domains, and have analytical abilities. When an organisation adopts HR analytics, it often has to undergo a cultural transformation in which data-driven decision-making is engrained in the company culture. Change resistance, a lack of support from important stakeholders, and a lack of leadership involvement may all be obstacles to the effective adoption and execution of HR analytics projects. HR professionals have a problem in effectively converting analytics findings into workable plans and solutions. Advanced analytical skills and strategic acumen are needed to interpret complicated data studies and incorporate them into HR policies and procedures.

CHALLENGES

AMAZON

Effective HR analytics implementation presents a number of issues for Amazon, as it does for many other big firms. The following are some of the major issues that are unique to Amazon:

Vast Amounts of Data

Massive volumes of data are generated by Amazon from a variety of sources, such as customer reviews, performance measurements, personnel records, and recruiting platforms. This enormous amount of data is difficult to manage and analyse, necessitating strong infrastructure and sophisticated analytics skills.



**Vidya and Gurusamy****Data Integration and Standardization**

Every business unit and region that Amazon works in has its own systems and procedures for handling HR data. It may be challenging and time-consuming to integrate and standardise data from many sources to provide a cohesive picture of the workforce.

Data Privacy and Security

Amazon is the repository for private employee data, including salary information, performance reviews, and personal information. For Amazon's HR analytics projects, ensuring adherence to data privacy laws and protecting data from security breaches are top considerations.

Talent Acquisition and Retention

Effective personnel recruiting and retention methods are crucial in light of Amazon's fast development and expansion. HR analytics may be used to anticipate employee attrition, evaluate the efficacy of recruiting, and find top talent. But in a cutthroat industry, finding and keeping HR specialists and trained data analysts with analytics experience might be difficult.

Workforce Diversity and Inclusion

At Amazon, inclusivity and diversity are essential principles. HR analytics may support an inclusive company culture, increase worker diversity, and spot possible biases in hiring and promotion procedures. But accomplishing diversity objectives and resolving inclusion issues need for a sophisticated grasp of workforce dynamics and cultural sensitivity.

WIPRO

Wipro's successful solution and expedited implementation facilitated the seamless historical data migration from a legacy HR system to the Azure cloud. The new platform efficiently manages an impressive volume of 500 GB of data daily. This robust HR analytics capability serves as a cornerstone for the client, empowering them to make informed, data-driven decisions and propelling their journey towards becoming an Intelligent Enterprise.

Notable are the concrete commercial advantages that the customer received:

Cost Savings

Over a period of 3.5 years, Wipro's solution produced significant cost savings of over \$960,000. This large cost savings highlights the efficacy and efficiency of the HR analytics system that was put in place.

Streamlined Processes

Wipro helped the customer get previously unheard-of productivity savings by improving Qlik refresh time from 3.5 hours to just 30 minutes and cutting the processing time of daily data loading from 15 hours to just minutes. Performance improvements in reporting and data integration were further aided by an amazing 80% decrease in loading times.

Improved Workforce Information

Managers now have simple access to workforce analytics insights thanks to the implementation of real-time dashboards. Better engagement, productivity analysis, and attrition risk prediction within the organization's talent pool were made possible by this increased visibility, which ultimately improved decision-making and strategic workforce management.

Effective Data Management

By improving programming flexibility, Wipro's solution made business data management more effective. This was made possible by Wipro's dedication to provide value-driven solutions that maximise resource usage and



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operational efficiency, as seen by the reduced development and maintenance costs attained. In conclusion, Wipro's revolutionary HR analytics solution met the client's urgent data transfer requirements and gave them cutting-edge analytics tools to set them up for long-term success. Wipro has been instrumental in expediting the client's path towards organisational intelligence and competitive advantage in the ever-changing business environment via the use of real-time insights and operational excellence.

TCS

With the release of the TCS Workforce Analytics Solution, TCS (Tata Consultancy Services) continues to broaden the scope of its range of proprietary frameworks and solutions. TCS's dedication to reducing programme implementation risks and speeding up time to value for clients experiencing data transformations is shown by its most recent acquisition. Other noteworthy solutions from TCS's portfolio complement this one:

DATOM

A thorough framework created for consultancy, advising, and evaluation services related to data and analytics maturity. In order to improve data-driven decision-making, DATOM™ helps businesses assess their present data capabilities, pinpoint areas for development, and create strategic roadmaps.

DAEzMo

The TCS Data and Analytics Estate Modernization Framework makes it easier to update outdated infrastructure and data systems. With the help of cutting-edge technologies and architectures, DAEzMo™ enables enterprises to fully use the potential of their data assets and spur creativity.

Decision Fabric

A cognitive business engine designed to support contextual industry offers and automate intricate business procedures. Across a wide range of sectors and domains, Decision Fabric™ maximises operational efficiency, delivers actionable insights, and improves customer experiences by using artificial intelligence and machine learning. From executives to data scientists, TCS offers a wide range of data and analytics services and solutions to meet the needs of all business stakeholders. TCS adopts a comprehensive approach to data centricity, addressing the full data value chain to achieve business performance. This strategy includes: Simplifying the Data and Analytics Landscape: TCS assists businesses in streamlining their data architecture and infrastructure to guarantee scalability, agility, and cost effectiveness while handling large amounts of data. Synergy Across Knowns and Unknowns: TCS encourages collaboration across structured and unstructured data sources, allowing businesses to draw insightful conclusions from both well-known and fresh data sets. Solution Deployment at Scale: TCS facilitates the smooth implementation of data and analytics solutions at scale by using its global delivery network, domain knowledge, and technological alliances to provide measurable business results for customers all over the globe. To summarise, TCS is a reliable partner for businesses looking to use data for growth, innovation, and competitive advantage in the current digital landscape. This is because of its dedication to innovation, proficiency in data and analytics, and all-encompassing approach to data-centricity.

Deloitte

In today's corporate environment, the requirement for increased worker reporting and analytical skills has grown more and more pressing. Deloitte: The need to be competitive and flexible in a market that is changing quickly has pushed workforce challenges like talent acquisition, retention, and development to the forefront of business agendas. Organizations have tactical obstacles in addition to strategic imperatives, such as the need for consolidated reporting, global and historical data management, self-service reporting, and basic reporting requirements, as well as the necessity for diverse HR systems. Consequently, in order to successfully handle these complex difficulties, firms need to improve their workforce reporting and analytics systems. Some of the problems and difficulties Deloitte has with its personnel are as follows:



**Vidya and Gurusamy****Planning of the Workforce**

To successfully prepare for future personnel requirements and resource allocation, organisations must take into consideration both present and predicted business demands as well as numerous workforce-related activities.

Recruitment of Talent and Mobility

Accurately assessing the success of recruitment initiatives and understanding the demands, trends, and barriers influencing worker mobility are critical. Strategic workforce planning requires evaluating the availability and demand for talent in the future.

Workforce Performance

Two essential components of workforce management are overseeing the efficient use of high performers and knowing the relationship between performance and retention. Putting in place a strong management structure aids in maximising employee performance.

Demographics and Diversity

Promoting an inclusive workplace culture and using a range of viewpoints and abilities require early identification of diversity gaps and an assessment of the success of diversity initiatives.

Learning and Development

Organizations may assess the success of development initiatives and make sure staff members have the knowledge and abilities needed to adapt to changing business requirements by mapping the progression to development.

RETENTION

For organisational stability and continuity, it is essential to invest in personnel holding vital roles and critical skills. Organizations may reduce the risk of losing developmental investments by monitoring and controlling employee turnover among important workers and by taking proactive steps to retain prized talent. Understanding the reasons behind employee departures, identifying those who plan to leave, and putting plans in place to address their concerns should be the main goals of retention initiatives. In conclusion, in order to successfully handle a variety of workforce difficulties, companies need to give top priority to improving workforce reporting and analytical skills. Organizations may achieve sustainable development and success in today's changing business climate, improve their personnel strategies, and build a diverse and inclusive workplace culture by using data-driven insights and strategic workforce management methods.

MICROSOFT

"Our HR teams' capabilities have been changed by modernising Microsoft data architecture," says Dawn Klinghoffer, Microsoft's Vice President of People Analytics. The Microsoft Data and Insights Engineering (MDEE) team has played a pivotal role in creating essential platform functionalities that guarantee data dependability and integrity across the enterprise's ecosystem, all while promoting engineering efficacy. Using an architectural pattern based on the Data Lakehouse is essential to this modernization endeavour. There is no need for separate data marts in this system since all information is included inside the Data Lake. Engineers may increase storage and computing independently with this unified method, increasing operational flexibility and efficiency. Every metric—be it headcount, performance management, staff learning, or any other area—follows the Data Lakehouse's uniform architectural design. This more efficient method improves the agility and reactivity of the HR analytics ecosystem while streamlining data administration. Engineers may now get profound insights into the health of the system by using telemetry dashboards, which makes it easier to continuously optimise infrastructure and code. Microsoft has thus seen huge cost reductions, with Azure expenses falling by over 50% over the course of two years. Additionally, agile development and DevOps processes are made possible by contemporary architecture, which helps the team produce iteratively and achieve commercial value more quickly. The HR Data and Insights team principal software engineer at MDEE, Mithun Manganahalli Goud, emphasises the value of standardised data and an organization-wide taxonomy. Data consumers are empowered with consistent and dependable insights thanks to this unified





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strategy, which guarantees that data is standardised and readily available across diverse projects and downstream systems. Essentially, the insights obtained from unified, normalised data are what really make this updated data architecture valuable. Microsoft is employing agile development processes and a uniform taxonomy to accelerate innovation and improve data-driven decision-making across the company.

CONCLUSION

Human resource management may be revolutionised by HR analytics, which gives businesses the ability to use data-driven insights to influence choices and achieve strategic goals. HR practitioners may get more insight into a range of workforce issues, including as talent acquisition, performance management, learning and development, retention, and diversity and inclusion, by using sophisticated analytics methods and tools. Organizations may abandon conventional, intuition-based methods to HR management and adopt evidence-based procedures that support organisational performance and are in line with business goals by using HR analytics. Organizations may discover trends, patterns, and correlations that guide strategic workforce planning, improve talent management procedures, and raise employee engagement and productivity by methodically gathering, evaluating, and interpreting workforce data. Additionally, HR analytics provide businesses the ability to proactively handle difficult workforce issues including skill gaps, diversity inequalities, talent shortages, and attrition concerns. Human resource professionals may create focused interventions and strategies to reduce risks, seize opportunities, and promote a culture of innovation and continuous improvement by recognising the underlying causes and predicting indications of these difficulties. But putting HR analytics into practise effectively calls for more than simply technical know-how; a comprehensive strategy that takes corporate culture, talent development, data governance, and change management into account is required. HR specialists need to interact with stakeholders, work across functional boundaries, and push for the business as a whole to embrace data-driven decision-making. HR analytics have the power to completely change how businesses handle their most important resource: their workforce. Organizations may get new insights, improve resource allocation, and foster competitive advantage and sustainable development in an increasingly complex and dynamic business environment by adopting analytics-driven HR strategies.

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Formulation and Evaluation of Immediate Release Tablets of Sacubitril and Valsartan

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ABSTRACT

This research aimed to develop and assess a combined Immediate Release (IR) tablet containing Sacubitril (SAC) and Valsartan (VAL) to address chronic heart failure. SAC and VAL are antihypertensive agents, and tablets were prepared using direct compression. Achieving optimal disintegration time was crucial for faster drug release in dissolution profiles. This was attained through superdisintegrants like Low Substituted hydroxypropyl cellulose USNF and Croscopovidone USNF. Formulation optimization trials included diverse compositions of binder Microcrystalline cellulose USNF, solubilizer Poloxamer USNF 188, Diluent Talc USP, Glidant colloidal silicon dioxide USNF, and Lubricant magnesium stearate USNF were employed. Tablets were coated with Opadry pink. Nine IR formulations (F1-F9) were devised using these constituents. Granules' preformulation parameters, e.g., bulk density, tapped density, compressibility index, and hausner's ratio, were analysed. Post-compression attributes encompassed thickness, hardness, friability, weight variation, disintegration time and drug content uniformity. *In-vitro* drug release studies in USP apparatus – II (Paddle) employed phosphate buffer pH 1.2 as dissolution media at 50 RPM and 37±0.5°C. The UV method determined % drug release over time intervals. F8 formulation emerged as the optimal choice based on evaluation. The chosen formulation proved stable in accelerated stability tests. *In-vitro* drug release of this formulation





aligned with a market reference of SAC and VAL tablets. All evaluations met reference benchmarks satisfactorily.

Keywords: Immediate Release tablet, Sacubitril, Valsartan, chronic heart failure, Low substituted hydroxypropyl cellulose, Crospovidone.

INTRODUCTION

Tablets are one of the most commonly used form of medication due to their practicality in self-administration, compact size, and ease of production. In the pharmaceutical industry, manufacturers of generic tablets usually concentrate on refining the mixture of ingredients to create a product that meets established quality standards. [1] This research project centers on the design and characterization of immediate-release oral tablets containing both Sacubitril and Valsartan. These tablets are intended to offer quick relief from chronic heart conditions. Immediate release tablets are created to swiftly break down and release their medication without any specialized features to control the rate of release, such as coatings or other techniques. This type of dosage form enables manufacturers to prolong their market exclusivity while providing patients with a convenient and easily manageable way to take their medication. Additionally, immediate-release and fast dispersing drug delivery systems may hold the potential to address certain challenges. In recent times, immediate-release tablets have gained momentum as a favored method of drug delivery. Their popularity stems from their ease of administration, rapid onset of action, affordability, and improved patient compliance. Furthermore, these tablets serve as a strategic tool for market expansion, extending the lifespan of products, and generating new opportunities. [2]

Shifting the focus to hypertension, a widely recognized condition characterized by consistently elevated blood pressure within the arteries, it emerges as a significant risk factor for various cardiovascular diseases, strokes, and associated complications. In 2019, the World Health Organization estimates that approximately 1.13 billion people across the globe were affected by hypertension. In India, the concern is equally prominent due to the nation's large population and evolving lifestyle factors. Different studies have yielded varying prevalence rates, yet it's estimated that around 25-30% of Indian adults contend with hypertension. [3-5] Similarly, chronic heart failure, a complex syndrome marked by the heart's inability to efficiently pump blood, leading to symptoms like fatigue, breathlessness, and fluid retention, holds substantial global importance. Worldwide estimates for 2017 revealed that over 26 million individuals were grappling with chronic heart failure. This condition is a primary cause of hospital admissions, particularly among older individuals. In the context of India, the situation mirrors that of hypertension. Chronic heart failure significantly contributes to cardiovascular-related hospitalizations, though the exact prevalence varies depending on the data source. [6, 7].

Sacubitril, a prodrug, undergoes a transformation into Sacubitrilat through de-ethylation facilitated by esterases. Sacubitrilat functions by inhibiting the enzyme neprilysin, responsible for breaking down various peptides, including those involved in regulating blood pressure and volume. Notably, it degrades bradykinin, an inflammatory mediator. Sacubitrilat displays slight solubility in water, limited solubility in dehydrated alcohol, and good solubility in methanol.[8-10]. On a distinct therapeutic front, Valsartan finds utility in treating high blood pressure, congestive heart failure, and reducing mortality in individuals with left ventricular dysfunction post-heart attack. Valsartan's mode of action revolves around blocking angiotensin II's effects, which encompass constricting blood vessels and stimulating aldosterone, ultimately contributing to elevated blood pressure. The drug interacts with the angiotensin type I receptor (AT1) as an antagonist. This mechanism deviates from that of ACE inhibitor drugs, which inhibit the conversion of angiotensin I to angiotensin II. As VAL operates at the receptor level, it holds the potential for more comprehensive angiotensin II antagonism, as angiotensin II arises from enzymes beyond ACE. VAL displays solubility in acetonitrile, near-insolubility in water, and solubility in methanol. [11-14]



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The primary objective of the present study is to develop and evaluate a combined immediate release tablet containing both SAC and VAL for the treatment of chronic heart failure. This research venture is poised to uncover novel insights into cardiovascular therapeutics through the synergistic effects of these pharmaceutical agents.

MATERIALS AND METHODS

Sacubitril, Valsartan and all other excipients were obtained as a gift sample from Aurobindo Pharma, Hyderabad, India. The rest of the chemicals and reagents were analytical grade and used without further purification. Double distilled water was used in the study. This research project was carried out in formulation research and development department of Aurobindo Pharma Ltd. Hyderabad, India.

Preformulation Studies

The term "preformulation study" refers to pharmaceutical and analytical research done before to and in support of formulation development activities of the drug substance's dosage form. Preformulation provides the fundamental knowledge needed to create a formulation suited for toxicological application. It provides the details required to describe the makeup of the medication substance and establish a framework for its administration to pharmaceutical patients. So, using the drug sample that had been collected, various preformulation investigations viz., description, melting point, pH range, bulk and tapped densities, flow properties, compressibility index, Hausner ratio, sieve analysis were carried out. [15-16]

Method of Drug Analysis

Preparation of standard stock solution

By individually combining 10 mg of Sacubitril and 10 mg of Valsartan in deionized water, phosphate buffer pH 6.8, and simulated gastric fluid (pH 1.2), standard drug solutions of Sacubitril and Valsartan were created. The volume was increased to 100 ml to create a stock solution with a concentration of 100 g/ml. A clear solution was obtained using ultrasonication.

UV Spectroscopic scan:

1. A stock solution of sacubitril and valsartan tablets produced in deionized water at a concentration of 100 g/ml. The UV spectrum was detected between 200 and 400 nm. The maximal isosbestic absorption point was determined to be 273.0 nm.
2. A stock solution of sacubitril and valsartan tablets made in phosphate buffer with a pH of 6.8 and a concentration of 100 g/ml. The UV spectrum was detected between 200 and 400 nm. 281.0nm was discovered to be the isosbestic point of maximal absorption.
3. A stock solution made in 0.1 N HCL using 100 g/ml Sacubitril and Valsartan tablets as the active ingredients. The UV spectrum was measured between 200 and 400 nm. A 275.0 nm value for the isosbestic point of maximum absorption was discovered.

Construction of calibration curve

A series of 10 ml volumetric flasks were filled to the mark with deionized water, phosphate buffer pH 6.8, simulated gastric pH 1.2, and prepared solutions of 5, 10, 15, 20, 25, 30 and 35 g/ml. Aliquots of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5-ml portions of stock solutions of sacubitril and valsartan were transferred to each flask. The UV Spectrometer was used to evaluate the solutions, and a calibration curve was created.

Drug – excipient compatibility studies

Drug-excipient compatibility studies were determined by using FTIR and DSC thermograms.

Formulation of Sacubitril and Valsartan tablets

SAC and VAL immediate release tablets were prepared by direct compression technique. Table 1 shows the formulations of Sacubitril and Valsartan Tablets.



**Preparation of Immediate release tablets of Sacubitril and Valsartan
Intragranular ingredients for Rapid Mixer Granulator (RMG):****Shifting**

- Shifted Microcrystalline Cellulose USNF (Avicel-PH-112) through a 425 μ m Sieve (ASTM mesh no# 40).
- Granulating Fluid (25% w/w of Poloxomer-188):
- Poloxomer was added to 25% purified water and stirred constantly for 30 minutes to obtain a clear solution.

Granulation in Rapid Mixer Granulator:

- The materials were loaded into the RMG and mixed for 1 minute with the impeller at a slow speed and the chopper off.
- The granulating fluid was added to the Rapid Mixer Granulator through a Peristaltic pump with the impeller at a slow speed and the chopper off over a period of about 10 minutes.
- The wet mass was kneaded for about 30 seconds with the impeller and chopper at a fast speed.
- The integrity of the wet mass was checked, and if necessary, an extra quantity of purified water (NMT 5% w/w of dry mix) was added to the RMG over a period of about 1 minute with the impeller at a slow speed and the chopper off.
- The wet mass was kneaded over a period of about 30 seconds with the impeller and chopper at a fast speed.
- The granulated mass was discharged from the RMG with the impeller at a slow speed and the chopper off into the Fluid Bed Equipment bowl.

Drying:

- The wet mass was air-dried in the fluid bed Equipment for 5 minutes.
- The wet mass was dried at an inert air temperature of 65 \pm 5 $^{\circ}$ C in the fluid bed equipment to achieve a LOD of NMR 2.0% w/w at 105 $^{\circ}$ C using an IR moisture analyzer in auto mode.
- After drying, the dried granules were unloaded into double-lined polythene bags in suitable containers.

Sifting and Milling:

- The dried granules were sifted through a 600 μ m sieve (ASTM mesh no #30) the retentions over the 600 μ m sieve (ASTM mesh no# 30) were collected separately.
- The retentions over the 600 μ m sieve (ASTM mesh no# 30) were milled through a Quadro co-mill fitted with 32R (0.032 inch, 813 μ m) at a medium speed and sifted through a 600 μ m sieve (ASTM mesh no# 30).
- If any retentions were observed after milling through the Quadro co-mill fitted with 32R (0.032 inch, 813 μ m), the material was milled at a fast speed and mixed with the sifted and milled granules, and the yield was calculated.
- The dummy granules were unloaded into double polythene bags in suitable containers.

Ingredients for Direct Compression (Part-2):

- Microcrystalline cellulose, dummy granules of part-1, and sacubitril-valsartan premix were co-shifted through a 710 μ m sieve (ASTM mesh no #25).
- Low Substituted Hydroxypropyl cellulose USNF, croscopovidone USNF, Talc USP, and colloidal silicon dioxide USNF were co-sifted through a 425 μ m sieve (ASTM mesh no# 40).
- The materials were co-sifted through a 710 μ m sieve (ASTM mesh no# 25).
- Sifting of Extra Granular Materials:
- Magnesium Stearate USNF was sifted through a 250 μ m sieve (ASTM mesh no #60).

Blending and Lubrication:

- The materials were loaded into a low-shear blender and blended for 20 minutes.
- The shifted magnesium stearate was loaded and lubricated for 3 minutes.
- The lubricated blend was unloaded into suitable containers with a double polythene-lined triple laminate aluminum bag with silica gel.



**Compression**

The blend was compressed into tablets using the following parameters (table 2).

Film coating

- Opadry pink was dispersed in Isopropyl alcohol (70% w/w) under continuous stirring for 15 minutes, and then purified water (30% w/w) was added, and stirring was continued for 45 minutes.
- The stirring was maintained until the end of the coating process. The tablets were loaded into the coating pan and prewarmed at a bed temperature of $38^{\circ}\text{C} \pm 5^{\circ}\text{C}$ with intermittent inching of the coating pan.
- The inlet air relative humidity (RH) was checked, and it was required to be not more than 10% throughout the coating process.
- The spray of the coating suspension was initiated at a bed temperature of $40^{\circ}\text{C} \pm 5^{\circ}\text{C}$, and the coating process continued until a weight buildup of 2.5% to 3.5% of the core tablet was achieved.
- The coated tablets were dried at a bed temperature of $40^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 30 minutes in inching mode.
- After drying, the tablets were cooled in the coating pan until the bed temperature reached not more than 30°C , with intermittent inching mode.

Post compression parameters

Various post compression parameters were evaluated such as thickness, diameter, hardness, weight variation test, friability, wetting time, drug content uniformity disintegration time, In-vitro dissolution studies drug kinetic studies and finally stability studies.

RESULTS AND DISCUSSION

SAC was discovered to be a solid, white to off-white powder with a distinct odor and no discernible flavor. SAC was readily soluble in distilled water and 0.1 N HCl. VAL was found to be an odorless, fine, white to virtually white powder that dissolved readily in both distilled water and 0.1 N HCl. The IR spectra of the pure drug and optimized formulation in figure 1 show that there was no interaction between the drug and excipients. Figure 2's representation of the DSC thermograms of SAC and VAL demonstrates that no evidence of drug-exciipient interactions was discovered.

Precompression parameters

The precompression qualities were the crucial criteria for figuring out whether a certain material was appropriate for the intended formulation. It was essential to comprehend the bulk density, tapped density, compressibility index, Hausner's ratio, and angle of repose because the objective was to produce IR tablets utilizing the direct compression technique. Table 3 displays the pre compression settings' results. According to the findings, it is a good material for formulation.

Post compression parameters

All of the prepared batches were thoroughly evaluated. Table 4 shows the results of the post compression settings that were acquired. The findings of all trial batches were compared and confirmed to be satisfactory in accordance with the pre-requisite standards. Finally, the comparative parameters were carefully scrutinized in order to identify the best batch and formula. The hardness of tablets was determined to be between 3.5 and 4.2 Kg/cm², and the friability was less than 1%. The disintegration time for formulation F8 is 30 seconds, which is the shortest among the formulation trials.

In-vitro drug release study

The formulated preparations underwent *in vitro* drug release testing using 900 mL of 0.1 N phosphate buffer dissolution media. The percentage of drug released was evaluated by sampling from the experimental medium and measuring absorbance at specific time points 3, 6, 9, 12, and 15 minutes using a UV spectrophotometer. The outcomes are presented in Table 5. Figure 3 shows the comparison of dissolution profiles of F1-F8 with innovator



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product. Upon a systematic comparison of the percentage of drug released, it was observed that all batches exhibited favorable release profiles that adhered to the specified criteria by the 15-minute mark. Notably, formulation F8 displayed the highest drug release after 15 minutes, making it a significant candidate for optimized formulation selection. According to the comparative research mentioned above, the created immediate release tablet of SAC and VAL's examined parameters are demonstrating encouraging results when compared to the commercial formulation. Finally, it was determined that manufactured immediate release tablets exhibit improved drug release, with 99.97 and 99.83% for SAC and VAL in house IR pills compared to 99.88 and 99.26% for SAC and VAL, respectively, in marketed tablets.

The In-vitro release data was submitted to different kinetic models, including zero order, first order, Higuchi, and Peppas, in order to understand the kinetics of drug release. Analysis of the mathematical fitting of the data revealed that, across all instances, the most suitable model for describing the release was the zero-order kinetic model, particularly for the optimized formulation F8. Consequently, the drug's release from the dosage form was determined to follow a zero-order kinetic pattern. Figure 4 illustrates the zero-order kinetic release, as well as the Peppas and Higuchi plots, for formulation F8.

Stability Study

%cumulative drug release was determined from stability studies of optimized (F8) formulated immediate release tablet of Sacubitril and Valsartan at 25°C, 60% RH and 40°C, 75% RH (2 month). Table 6 shows the results of stability studies. The tablets show no significant change in the % drug release after 2 months on specified conditions. This shows that the prepared tablets were stable. The results of stability studies were shown in table 6.

CONCLUSION

This study developed and assessed immediate release tablets of Sacubitril and Valsartan using direct compression with various superdisintegrants. The process encompassed pre-formulation, formulation, evaluation, and stability analysis. Nine formulations were created, varying superdisintegrant concentrations. The best formulation was chosen based on evaluation parameters. UV spectrometry determined drug content. Pre-formulation tests (FTIR, and DSC) showed no drug-exciipient interactions. Tablets were prepared through direct compression, subjected to pre-compression tests, yielding satisfactory outcomes. Post-compression evaluations, including hardness, weight variation, friability, drug content, disintegration time, and dissolution, were conducted. Formulation F8 emerged as the optimized choice. Stability studies confirmed the optimized formulation's robustness, comparing favorably with predefined standards. *In-vitro* dissolution tests indicated the formulated tablets outperformed marketed counterparts.

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Table 1: Formulation of Sacubitril and Valsartan Tablets

Ingredients	Weight of ingredients per tablet (mg)								
	F1	F2	F3	F4	F5	F6	F7	F8	F9
Sacubitril	97	97	97	97	97	97	97	97	97
Valsartan	103	103	103	103	103	103	103	103	103
Low Substituted hydroxypropyl cellulose USNF	10	20	30	0	0	0	10	20	30
Crospovidone USNF	0	0	0	30	40	50	30	40	50
Microcrystalline cellulose USNF	75	65	55	55	45	35	45	25	5
Poloxamer USNF,188	15	15	15	15	15	15	15	15	15
Talc USP	60	60	60	60	60	60	60	60	60
Colloidal silicon dioxide USNF	40	40	40	40	40	40	40	40	40
Magnesium stearate USNF	20	20	20	20	20	20	20	20	20





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Table 2: Compression parameters

Parameters		Description
Physical appearance		White colored unscored, ovaloid, biconvex, tablets with 'SV' on one side and '200' on other side.
Tooling	Size	16.70 x 6.00 mm
	Shape	Oval shaped, bevel concave punches
Average weight (mg)		420.00 ± 3%w/w (407.40 – 432.60)
Hardness (KP)		6.0 – 12.0
Thickness (mm)		5.20 ± 0.30 (4.90-5.50)
Uniformity of Weight (mg)		± 5% of target weight

TableNo.3: Results of Pre-compression parameters

Parameters	Bulk Density(g/cm ³)	Tappe density (g/cm ³)	Carr's Index (%)	Angle of Repose (θ)	Hausner Ratio
F1	0.59	0.75	12	25.25	1.2
F2	0.63	0.73	13.69	26.27	1.15
F3	0.61	0.71	14.08	27.32	1.16
F4	0.60	0.70	13.79	26.65	1.16
F5	0.62	0.71	12.67	28.42	1.14
F6	0.64	0.74	13.51	29.96	1.15
F7	0.63	0.72	12.5	25.07	1.14
F8	0.66	0.76	13.15	26.56	1.15
F9	0.64	0.75	14.66	27.60	1.17

Table 4: Results of post compression parameters

Evaluation of Post Compression Parameter								
Formulation Code	Hardness (kg/cm ²)	Friability (%)	Weight variation Test (%) ±S.D	Thickness of Tablets (mm) ±S.D	Wetting Time (Seconds)	Disintegration Time(sec) ± S.D	% Drug content	
							Sacubitril	Valsartan
F1	3.7	0.69	102.3±0.15	4.51±0.79	38.91±1.09	42±0.73	99.60±1.42	98.00±1.15
F2	3.9	0.71	101.2±0.66	4.97±1.18	38.24±0.97	51±0.58	99.80±1.31	99.36±1.24
F3	4.2	0.68	98.9±0.301	5.04±0.98	40.11±1.13	55±0.65	99.93±1.22	99.04±1.32
F4	3.6	0.71	100.6±0.23	5.15±0.92	39.15±1.21	34±0.59	99.71±1.36	99.63±1.14
F5	3.5	0.74	102.1±0.18	5.11±1.21	38.69±1.31	41±0.85	99.78±1.24	99.56±1.28
F6	4.1	0.72	101.3±0.26	5.27±1.33	40.12±1.28	45±0.71	99.62±1.45	99.86±1.13
F7	3.7	0.69	101.6±0.22	4.85±1.12	39.94±0.99	34±0.64	99.90±1.18	99.77±1.43
F8	3.9	0.71	99.80±0.18	4.88±0.97	39.76±1.08	30±0.48	99.55±1.38	99.74±1.23
F9	4.1	0.70	100.8±0.21	5.43±1.27	40.57±1.19	35±0.40	99.86±1.29	99.00±1.2





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Table 5: In-vitro Drug release profile of IR tablets

Sacubitril										
Time (min)	F1	F2	F3	F4	F5	F6	F7	F8	F9	Innovator
3	34.25	34.41	27.47	26.46	26.42	35.43	34.27	33.46	27.03	35.50
6	51.68	50.41	40.17	36.39	37.91	58.35	50.27	49.16	40.34	46.40
9	66.67	65.27	53.26	44.41	46.61	65.14	67.69	78.31	53.46	79.40
12	87.04	86.84	73.04	58.16	62.49	77.16	86.43	86.64	72.79	88.68
15	91.85	90.62	85.84	75.07	83.29	80.39	98.61	99.97	98.16	99.88
Valsartan										
3	30.24	31.11	32.46	32.24	32.18	33.15	33.65	34.15	34.65	32.24
6	51.18	53.56	56.11	63.18	53.56	53.83	65.27	66.71	68.15	53.18
9	79.12	69.38	70.18	70.12	68.56	69.36	79.32	79.28	78.24	70.12
12	88.92	82.18	87.34	85.92	84.24	79.03	86.47	88.91	87.35	85.92
15	94.42	93.76	95.10	92.26	95.16	90.93	98.33	99.83	99.13	99.26

Table 6: Results of stability studies

Time (min)	Cumulative % Drug Release							
	Stored at 25°C Temperature				Stored at 40°C Temperature			
	After 1 Month		After 2 Months		After 1 Month		After 2 Months	
	Sac	Val	Sac	Val	Sac	Val	Sac	Val
3	39.57±0.99	40.76±0.87	38.98±1.14	38.79±1.34	39.72±0.99	38.78±0.89	39.61±1.03	39.89±1.08
6	60.28±1.05	59.04±1.32	61.02±1.11	59.93±0.97	59.34±1.25	59.92±1.17	58.92±0.95	59.76±1.14
9	79.95±1.09	69.73±1.04	77.88±1.08	70.02±1.24	70.11±1.08	71.05±1.22	70.05±1.14	69.92±1.13
12	86.11±1.14	88.91±1.08	80.76±1.10	88.61±1.13	80.02±1.16	88.63±0.98	80.20±1.07	89.81±1.15
15	99.03±1.02	99.12±1.19	99.23±1.09	99.17±1.29	99.91±1.21	99.40±1.08	99.75±1.19	99.97±1.09

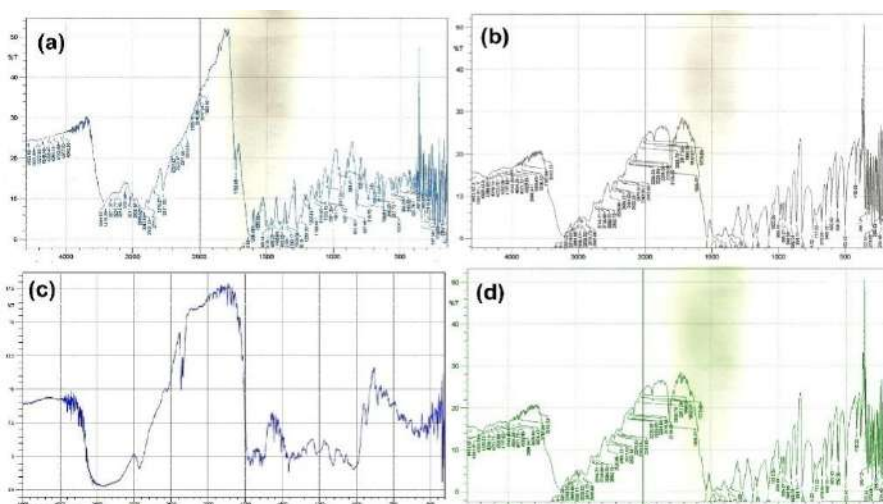


Figure 1: FTIR spectra of (a) Sacubitril; (b) Valsartan; (c) Sacubitril with Polymer mixture; (d) Valsartan with Polymer mixture



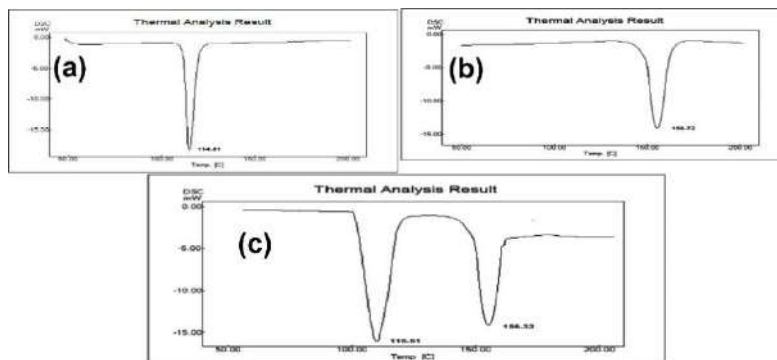
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Figure 2: DSC thermograms of (a) Sacubitril; (b) Valsartan; (c) Polymer mixture

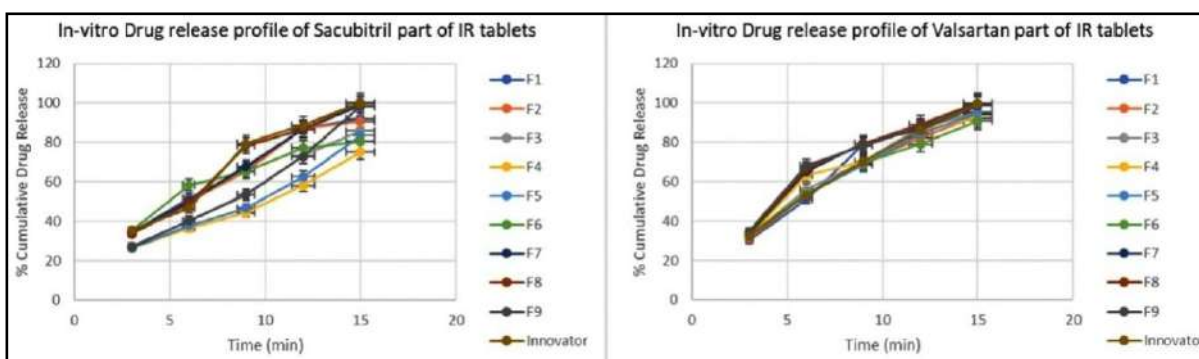


Figure 3: In-vitro drug release profile of SAC and VAL

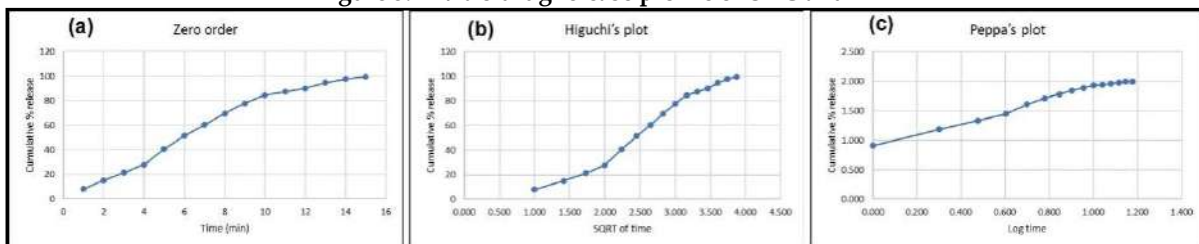


Figure 4: (a) Zero order kinetic release; (b) Higuchi; (c) Peppas plots, for formulation F8.





RESEARCH ARTICLE

Effectiveness of Active Release Therapy and Positional Release Technique for Gastroc Soleus Trigger Point Release on Calf Muscle Tightness in Young Adults

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ABSTRACT

Calf tightness is most common condition among young adults. Tight calves can be uncomfortable and cause difficult walking. Tightness of these muscles in turn leads to the formation of trigger points within the muscles. Active Release Technique is the combination of site specific manual pressure with precise patient movement (lengthening the muscle through the ROM). Positional Release Therapy increases the flexibility of muscle by keeping the muscle in shortened position for a period of 90 secs while maintaining a sustained manual pressure. Based on inclusion criteria, 70 participants with calf tightness along with gastrosoleus trigger point were screened and included in a study. Participants were randomly allocated into GROUP A : Active release technique with conventional exercises and GROUP B : Positional release therapy with conventional exercises. NPRS, DLT and dorsiflexion ROM were taken as an outcome measures, analysis were performed. The statistical analysis revealed a significant improvement in ROM, dorsiflexion lunge test and a significant decrease in pain after trigger point release in both groups [$p < 0.0001$]. However, intergroup analysis revealed that group A is significantly more efficient in improving range of motion and dorsiflexion lunge test with the lowering pain levels. The study demonstrates that active release technique and positional release therapy have a good impact on increasing range of motion and reducing pain. Nonetheless, group A (ART) exhibits more progress than group B (PRT). Hence, it can be said that Active Release Therapy is superior to PRT for relieving gastrosoleus trigger points caused by calf tightness in young adults





Keywords: Active release technique, positional release therapy, calf tightness, trigger point

INTRODUCTION

The bulk of muscles are attached to bones via tendons, allowing forces and motions generated during muscle contractions to be transmitted to the skeleton. Skeletal muscle makes up level of approximately 50% of such total body mass. [1] The gastrocnemius & soleus muscles, which connect here to powerful tendon of (calcaneal) Achilles, It makes up the calf muscle. Both posture control and gait are significantly influenced by it. As just a result, a decrease in ankle dorsiflexion along with a number of disorders like shin splints, Achilles tendinitis, plantar fasciitis, and muscle and joint strains are all associated with calf muscle tightness (that is, less flexibility as well as higher tightening).[2] There is a strong history of evidence showing that people with neurological impairments and spasticity have tightness of the gastrocnemius muscle and soleus muscle. [3] Trigger points develop within the muscles as a result of these muscles being too tight.[4] Localized tenderness inside a tight band of muscle fibres is known as just a trigger point. They are viewed as a subsequent phenomena to injury, postural problems, poor muscular balance, and stress. [5] The presence of intense sensitivity at a nodule in a palpably tight band was described by Simons et al. as the muscular trigger point. Upon digital compression or spontaneously, they have the capacity to induce referred pain. Trigger points are small, localised, very painful spots of muscle inside a taught band of muscle, according to the clinical definition. In reaction to digital pressure or dry needling, they display jump sign (whole body movement) or a local twitch response (muscle fasciculation).[6]

There are two different kind of myofascial trigger points; it can be either active or latent trigger point. [7] Myofascial trigger points have altered levels of calcitonin gene-related peptide, serotonin bradykinin, substance P, and pH reduction in their chemical makeup. In an MTrP site, it was discovered that the local oxygen saturation was less than 5% of normal. Muscle nociceptors are activated after MTrP as a result of low oxygen levels and an increase in inflammatory mediators. This causes local soreness and referral pain. According to a theory, The injured muscle fibres shrink as a result of either excessive calcium ions being released from the damaged muscle fibres or excessive acetylcholine being released from the appropriate motor end plate which creates tight bands. [8] A technique called Active Release Technique (ART) is used to treat soft tissue injuries and dysfunction brought on by constant physical activity. [9] The practitioner uses digital tension during ART treatment along the tissue fibres at painful adhesion sites. The next step is to give the patient instructions to actively extend the shortened tissue fibres at the damage location. [10] Positional release therapy is another manual therapy method used to treat trigger points (PRT). This technique comprises passive body alignment, which is said to result in both short-term and long-term decreases in trigger point discomfort as well as pain relief for musculoskeletal disorders.[11] In contrast to stretching or lengthening the muscle, a technique used in osteopathic manual method called positional release treatment, also referred as strain counterstrain, tries to increase muscular mobility by shorten the muscle to promote relaxation response. The procedure entails holding the restricted joints and muscles in the "position of ease or comfort" (that is the direction opposite to that of stretch or strain) for at least 90 seconds. Any tissue involved in the pathophysiology of somatic joint dysfunction has been recommended to be treated using positional release therapy. [12]

MATERIAL AND METHODOLOGY

70 Subjects were selected from Sainath hospital and Ahmedabad Physiotherapy College. Subjects whose age between 20-30 years and those who met the inclusion criteria are selected.

Inclusion criteria

Willingly participate in the study, Both male and female participants, 20 to 30 years of age, At least one trigger nodule within a gastrosoleus muscle, Ankle dorsiflexion ROM less than 20 degrees, Pain intensity is more than 4 in NPRS, Jump sign positive.



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Congenital deformity of foot, Any fracture or Infection in the lower limb, Peripheral vascular disease, Rheumatoid arthritis

Procedure of outcome measure**NPRS**

The Numerical Pain Rating scale (NPRS) will be used to record the pain of gastrosoleus trigger point in calf tightness, where 0 stays for no pain and 10 stays for maximum pain. Each participants will be asked to rate their current level of pain.

Range of motion

To ascertain whether the subject's dorsiflexion was restricted or not, a goniometer which measures the angle of motion at each joint in the human body was utilised. The individual was asked to relax their ankle joint and maintain a 90-degree neutral position while sat on the bed with their leg extended but without touching the ground. Next, while the axis was placed on the outer malleolus and the stationary arm was placed on the fibular, the moving arm was placed in the side line of the sole of the foot relative to the fifth toe. In this state, the subject performed dorsiflexion, during which the corresponding values were measured. Then, the data will be obtained. [13]

Dorsiflexion lunge test

Placing the foot perpendicular to a wall and lunging the knee towards the wall is how the dorsiflexion lunge test is carried out. Up until the foot reaches its maximal dorsiflexion range, it is gradually pushed farther away from the wall. The subtalar joint must be locked, and the heel must remain firmly planted on the floor. Less than 9 to 10 cm is deemed limited when measuring the distance from the foot to the wall. [14]

Procedure of intervention**Group A: Active Release Technique**

The subject will be lying on prone position with their knee extended to 90 degrees and their ankle kept in plantar flexion during the gastrocnemius exercise. While the therapist sustained deep manual pressure on the trigger point, the patient voluntarily extended their knee and dorsi-flexed their ankle. The exercise will be repeated 15 times.

In order to do a soleus test, the subject will be in prone lying with their knee extended and their ankle plantarflexed outside of the plinth. The patient actively dorsi-flexed their ankle as the therapist sustained deep manual pressure on the trigger spot. There will be 15 repeats. (3)

Group B: Positional Release Therapy

For the gastrocnemius, the subject will be on prone position with their knee bent at a 90-degree angle and their ankle plantar flexed. A deep manual pressure will be applied by the therapist and held in place for 90 seconds. Three times will this process be repeated. In order to test the soleus, the subject will be lying on prone with their knee extended and their ankle plantar flexed. The therapist used intense manual pressure for 90 seconds over the palpated trigger point. Three times will this process be repeated. [4] Both groups will receive standard physiotherapy care, which will involve the use of an ice pack, eccentric plantar flexor movements, and lengthening of the gastrocnemius and soleus muscles. The ankle dorsiflexion range of motion will be measured to use a ½ circle goniometer, a dorsiflexion lunge test, and a numeric pain rating scale for both groups immediately following the intervention. We will record NPRS results and ROM values.

RESULT

Data were entered into the SPSS version of 26 and effect was shown on the comparison of active release therapy versus positional release therapy on gastrosoleus trigger point. The study involved 70 young individuals; GROUP A included 17 female participants and 18 male participants, whereas GROUP B had 18 female participants and 17 male





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participants. Table suggested that the Between Group comparison used Mann-Whitney U statistical Test and **p value is <0.001**. Between group comparison **Mann Whitney U** statistical test was used and within group **Wilcoxon signed rank** test was used. Improvement showed in both groups but according to mean, group A had superior effect compared to group B. Results of the present study showed that one session of the active release technique had a significant effect on flexibility and pain in gastrosoleus trigger points with calf tightness in young adults.

DISCUSSION

In this study, the effectiveness of active release method and positional release treatment for calf muscular tension in young people is investigated. James W. George, et Al. [2006] conducted a research to look at changes in electromyography and a reliable self-administered outcome measure following the use of active release method to CTS patients. In the study, there were five CTS patients. Before starting the first course of therapy, subjects completed the Boston Questionnaire (BQ) and an EMG test. A strategy designed to influence the median nerve three times per week for two weeks was used to treat participants utilising the Active Release method. so it was concluded that for Carpal tunnel syndrome sufferers, the active release approach is a useful kind of conservative therapy.[15] The most fundamental way that ART functions is by releasing tension in the muscles, scar tissue, and muscle adhesions and restrictions. Scar tissue is used by our bodies as a bandage repair when muscles or other tissues are overworked or damaged. This is a typical stage of the recovery process. However, if the cause of the damage is not fixed, the tissue will develop an excessive amount of scar tissue, which will then become a problem. The process used to do this involves the therapist first positioning the muscle at its shortest position (by moving the adjacent joints), applying tension with the thumb or fingers, and then lengthening the muscle throughout its range of motion while maintaining that tension. Any adhesions or scar tissue that could exist throughout the whole length of the muscle are broken down by doing this. It is vital to note that if the stress cause is not identified and the scar tissue is not broken up, the pain, numbness, or other symptoms may not go away.

In 2014, Mohamed MN, et al. looked at how the positional release approach affected persons with persistent mechanical low back pain. Both sexes were represented in the group of twenty-two Chronic MLBP patients, who were randomly divided into two equal groups of sixteen each. The therapeutic exercises that Group A (the control group) underwent included (Strength and Stretch exercises for back and abdominal muscles). Three days a week for four weeks, the experimental group (Group B) engaged in treatment activities based on positional release approach. The Oswestry Impairment Scale was used to assess functional disability, lumbar range of motion, and pain using the Visual analogue scale. In those with persistent mechanical low back pain, The positional release technique is considered to be a successful treatment for reducing pain, improving functional limitations, and increasing lumbar range of motion. [16] Positional release therapy, also known by the parent term strain counterstrain, is a treatment strategy that targets somatic dysfunction by arranging the body's tissues, limbs, and posture in a relaxed position. According to Jones, somatic dysfunction frequently causes tissues to kink or knot, which causes pain/discomfort, spasms, and a reduction in range of motion. PRT simply untangles tissues by gently twisting and pressing the tissues together to release tension from the knot, much like one would untangle a knotted necklace. When one chain link is untangled, the surrounding links also disentangle, providing significant pain relief. This study demonstrates how active release method and positional release treatment help young people with calf muscle stiffness by increasing flexibility, reducing discomfort, and improving range of motion. hence, from result we confirmed that one session of active release technique shows more improvement in gastrosoleus trigger point release of calf tightness in young adults while comparing both groups, Group A exhibited more improvement than Group B.

CONCLUSION

The study demonstrates that active release technique and positional release therapy have a good impact on increasing range of motion and reducing pain. Nonetheless, group A (ART) exhibits more progress than group B





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(PRT). Hence, it can be said that Active Release Therapy is superior to PRT for relieving gastrosoleus trigger points caused by calf tightness in young adults.

Clinical implication

According to this study, people with gastrosoleus trigger points brought on by calf muscular tension respond well to physical therapy treatments. When treatments were administered in a certain order, active release therapy outperformed positional release technique. To identify the important changes in pain, functional capability, and range of motion (ROM), this study used both subjective and objective outcome measures.

Limitation

Long-term follow-up was not conducted, None of the control group was used, Sample size limited.

Future recommendation

Long-term interpretation can be possible.

It would be recommended that future studies use a greater number of participants.

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Table 1: MEAN GENDER DISTRIBUTION

	PRT		ART	
	N	%	N	%
Female	18	51.4	17	48.6
Male	17	48.6	18	51.4
Total	35	100.0	35	100.0

Table .2 – MEAN AGE DISTRIBUTION

Outcome Measures	PRT			ART		
	N	Mean	SD	N	Mean	SD
AGE	35	24.29	2.64	35	24.66	2.68

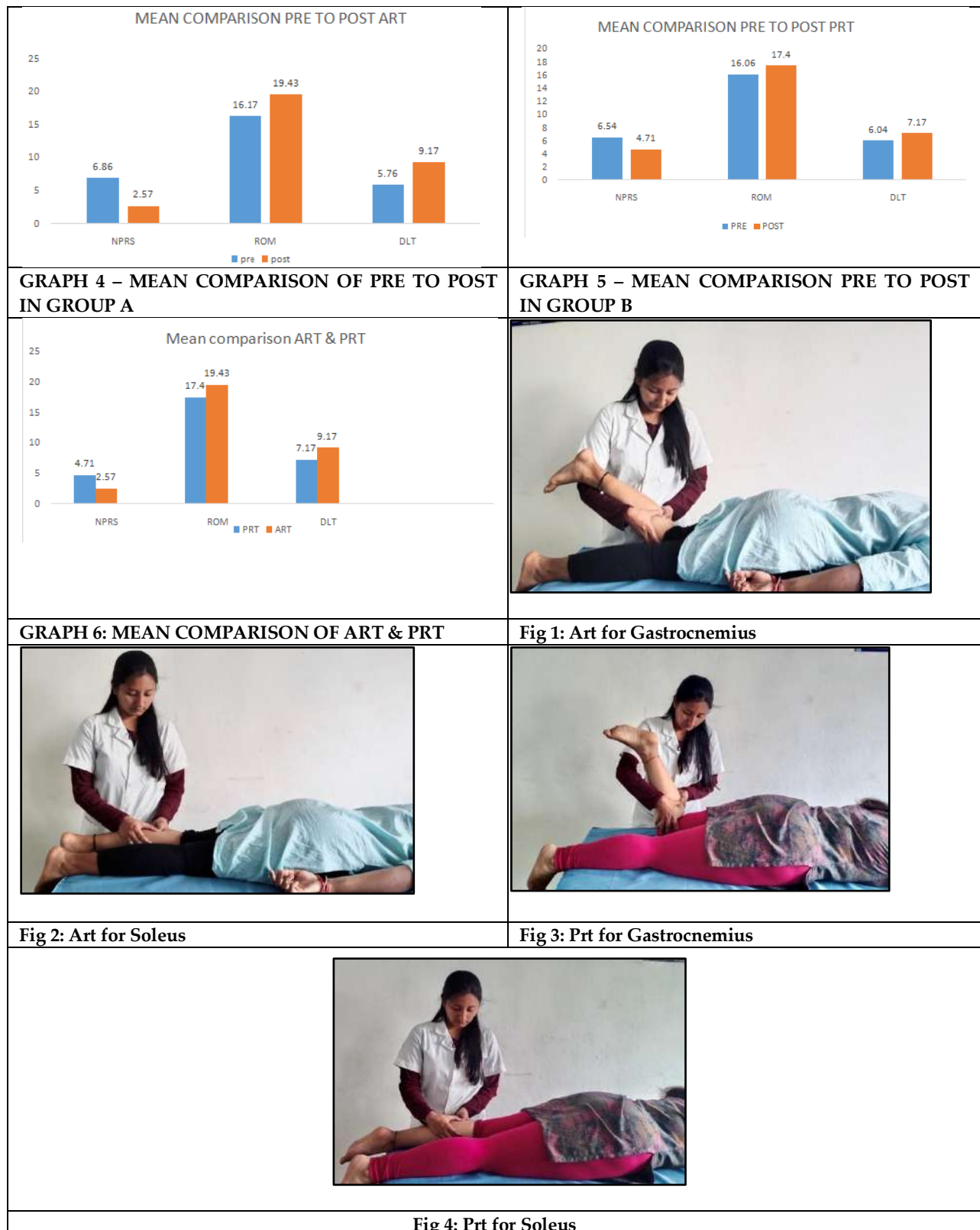
Table 3: COMPARISON OF PRE AND POST MEAN IN GROUP A AND GROUP B & COMPARISON BETWEEN THE GROUP

Outcome Measures		PRT		P-VALUE	ART		P-VALUE	P-VALUE (between group)
		Mean	SD		Mean	SD		
NPRS	PRE	6.54	1.42	P<0.001	6.86	1.22	P<0.001	0.21
	POST	4.71	1.64		2.57	1.24		P<0.001
ROM	PRE	16.06	1.63	P<0.001	16.17	1.38	P<0.001	0.75
	POST	17.40	1.33		19.43	0.70		P<0.001
DLT	PRE	6.04	1.30	P<0.001	5.76	1.20	P<0.001	0.29
	POST	7.17	1.17		9.17	0.75		P<0.001





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Foundational Literacy and Numeracy: A Theoretical Exploration and Current Status

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ABSTRACT

The long term success and development of the children depends heavily on their accomplishment of early scholastic competencies such as literacy and numeracy. Several studies have reported the strong correlation between young children Foundation Literacy and Numeracy (FLN) skills and their subsequent academic success. Presently, India is close to the aim of universal enrolment of the children in schools but far away from developing the FLN skills among their children. India is facing the serious learning crisis and to overcome from it, the collaborative efforts are required. The present study highlights the present status of FLN skills among children in India. Additionally, this study rigorously analyzes the key factors that play a significant role in enhancing these fundamental skills and highlights that besides school factors, there are enormous factors that influence the FLN skills of the children. Furthermore, the previous studies don't provide a cyclopedic theoretical description of FLN skills. Therefore, this study is inclined to provide a cyclopedic theoretical description of FLN skills and certain suggestions to researchers, educators, teachers and policymakers.

Keywords: Early Education, Engagement, FLN Skills, Life Long Learning





INTRODUCTION

FLN skills are the cornerstones of a child's education, serving as the building blocks upon which their academic success and lifelong learning is constructed (Report on state of FLN in India, 2023). These fundamental skills encompass the ability to read, write, and comprehend written language, as well as to understand and manipulate numerical concepts (ASER, 2022). In the formative years of a child's life, the acquisition of these skills lays the groundwork for their intellectual and social development, enabling them to engage with the world in meaningful ways (Henningham, 2013). The mastery of numeracy and literacy not only empowers children to excel in their formal education but also equips them with the essential tools to navigate everyday life, solve problems, and communicate effectively (Position paper on Early Childhood Education, 2006). Literate and numerate children are better equipped to express themselves, engage with their peers, and make informed decisions, setting the stage for success in school and beyond. These skills form the basis for more advanced learning and problem-solving throughout a child's educational journey (Duncan *et al.*, 2007). In the early years, children develop foundational literacy skills such as phonemic awareness, letter recognition, and vocabulary acquisition. These skills provide the tools needed to decode and comprehend written language, opening the door to a world of knowledge and imagination (NIPUN BHARAT 2021). By investing in the evolution of numeracy and literacy skills, we empower children to become curious, confident, and capable learners, equipping them with the tools they need to thrive in an ever-evolving world (Ball, 1994). Nurturing these foundational skills is a shared responsibility of educators, parents, and communities. Several factors play a pivotal role in enhancing these skills in children. First and foremost, a nurturing and stimulating home environment is essential (Kumar and Behera, 2022 & Godwin *et al.*, 2016).

Early intervention and support can make a significant change in a child's educational journey. Parents and caregivers who read to their children, engage in meaningful conversations, and provide access to a variety of age-appropriate books and educational materials create a strong foundation for literacy (International Labour Organization, Geneva, 2012,). Quality early childhood education is another key factor. Enrolling children in well-designed preschool programs helps them develop essential cognitive and social skills, including early numeracy and literacy (International Labour Organization, Geneva, 2012 & Qadiri and Manhas, 2017). Skilled and dedicated educators in these programs provide a structured learning environment that fosters a love for reading and mathematics. Additionally, exposure to numeracy concepts through everyday activities like counting objects, measuring ingredients, or discussing numbers during play can boost a child's mathematical skills. Furthermore, a print-rich environment, both at home and in educational settings, promotes literacy. Having easy access to books, magazines, and other reading materials encourages children to explore and enjoy reading. Similarly, the presence of numeracy resources, such as math games and manipulative, can make mathematical concepts more accessible and engaging. Lastly, individualized instruction and support are crucial for children with diverse learning needs. Recognizing and addressing learning differences early ensures that each child has the opportunity to develop strong foundational skills. In summary, a combination of a supportive home environment, quality early education, a print-rich setting, and individualized support are all vital factors that enhance foundational numeracy and literacy skills in children, setting them on a path toward academic success and a lifelong love for learning. Based on our information, no studies have clearly provided a comprehensive description of the theoretical perspectives that guide the understanding and development of FLN skills. However, theoretical perspectives provide frameworks for understanding how individuals acquire these skills and guide educational approaches. A solid theoretical foundation ensures systematic, evidence-based instruction, contributing to effective skill development in learners. The present study is inclined to present an overview of theoretical perspectives that guide the development of FLN skills among learners.

The overall objectives of this study can be outlined as follows:

- To highlight the present status of FLN in India according to the current reports.
- To explore the factors that influences the development of FLN skills among children.
- To provide an overview of theoretical perspectives that guides the development of FLN skills among learners.



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- To suggest recommendations to researchers, educators, teachers and policymakers for the development of FLN skills among children.

The organization of the study is described as follows: In section 2, we present the related work. Section 3, highlights the present status of FLN skills in India. Section 4; discuss factors that influence the development of FLN skills and Section 5, include the implications for researchers, educators, teachers and policymakers and conclusion of the study.

Related Work

The previous works on FLN have presented the importance and level of FLN skills among children. As mentioned by UNESCO, report on the state of global learning poverty, 2022, FLN skills are very important as they build a strong path for the later learning and provide a cumulative advantage (Aunola *et al.*, 2004). According to UNESCO, the report on the state of global learning poverty, 2022, FLN skills are necessary to fulfill children human right to quality education. The report on State of foundational literacy and numeracy in India, 2023, has highlighted that investment should be done in developing the FLN skills of children for high private and social returns (Bhalotra and Zamora, 2006). The report on the state of global learning poverty, 2022 (UNESCO) has further highlighted that the equity and stability of a nation are threatened when young children lack FLN competencies. According to code Duncan and Magnuson (2011), learning gaps increase over the course of a child's education if FLN skills are not acquired at early years. The report on State of foundational literacy and numeracy in India, 2023, has stated that only a sound foundation of FLN Skills can guarantee the quality of human capital.

The existing studies have been highlighted the poor level of FLN among children in India (ASER report, 2022 & Foundational learning study (FLS) 2022, report. The recent ASER Report 2022 has stated that overall only 1 out of 4 children in grade 5 and almost half of the children in grade 8 in India can read simple English sentences whereas others do not. NEP 2020 also noted the learning crisis prevalent in India and thus focused to attain Foundational literacy and numeracy by Grade 3. The background studies have also delineated the factors that affect the FLN skills of the children. After the thorough review of related literature, the investigators have provided the concise picture of factors that are at the leading edge for the development of FLN skills in India. Additionally, the investigators have provided an overview of the theoretical framework or perspectives that would help educators to enhance the FLN skills among children in India.

Present Status of FLN in India

After the commencement of constitution, the primary goal of the government was to ensure that every child had access to education. Therefore, the first priority of the government was to expand educational opportunities so as to make them available and accessible to all sections of the society (Report on Quality of Elementary Education in India, 2020). Presently, the Gross Enrolment Ratio at the Primary level of education has increased to 103.3 percent in 2020-2021 from its prior level of 102.7 percent in 2019-2020 (UDISE+ 2020-21 Report). The enrolment rates have been improved and the aim of Universalization of education has been achieved to the larger extent but does this increased enrolment guarantee learning? Although the universalization of elementary education is an important step towards ensuring learning opportunities but it doesn't guarantee that learning will occur. According to the study conducted by Kumar *et.al*, 2023, only enrolment in schools doesn't ensure learning but quality education given in schools can enhance the learning level of the children. Learning is also dependent on number of variables such as the quality of education, teaching methods, teacher quality, infrastructure (Report on state of FLN in India, 2023), leadership and support systems in place (Dockett and Perry, 2009). It is evident from the studies that even after the perfect enrolment rates the students in India are unable to read and understand the grade level text and perform the simple numerical calculations (NEP 2020 & ASER 2022). The report of ASER (2018) highlighted some serious causes of existing learning crisis i.e., illiterate parents, rote methods of learning, lack of school readiness, poor training of teachers and lack of monitoring the progress in early grades. However the ASER reports (2019-2022) also showed the deep concern for the learning crisis prevailing in India. Additionally, the National Achievement Survey (2017) also highlighted the deep learning crisis that is pervasive in India and reported that 1 in 3 kids in grade 3 struggle to comprehend short texts, and 1 in 2 cannot utilize math's to solve problems in their daily lives. The recent document, Foundational learning study (FLS) 2022 report has also noted that at the national level 11% of students did not have



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the basic grade-level skills, 37% had limited skills, 21% had a sufficient skills while only 34% had superior skills. The report on Foundational Literacy and Numeracy (2023) has highlighted that the pandemic (Covid-19) exacerbated the learning crisis that the world was already experiencing in the foundational years of children. In India, 82% of students in India lost at least one specific arithmetic skill and 92% of students lost at least one specific language ability from the prior school year (UNICEF, 2022). If we look at the scenario, we will find that progress has been made in some regions but challenges still persist, including disparities in access, quality of education, and teacher training. A concerted effort is needed to address these issues and ensure a more equitable and effective foundation for learning globally.

Factors Influencing FLN Skills

Enhancing foundational numeracy and literacy skills in children is crucial for their overall development and academic success. Several factors play a pivotal role in facilitating this essential learning process. First and foremost, a supportive and stimulating learning environment at home and in educational institutions is paramount. Parents and caregivers who actively engage with their children in reading and math-related activities create a strong foundation for these skills. Additionally, exposure to a wide variety of age-appropriate books, educational games, and interactive digital resources can further bolster a child's literacy and numeracy abilities. Quality instruction and passionate teachers in schools are equally vital. Teachers who employ innovative teaching methods, personalized approaches, and a love for learning can greatly influence a child's enthusiasm for acquiring these fundamental skills. Moreover, fostering a growth mindset in children, where they view mistakes as opportunities to learn and grow, can be a significant factor in their development. Regular practice, consistency, and positive reinforcement help children build confidence and competence in numeracy and literacy. Finally, a diverse and inclusive curriculum that caters to individual learning needs and cultural backgrounds ensures that every child has the opportunity to excel in these foundational skills. By incorporating these factors, we can create an environment where children are well-equipped with the tools they need to thrive academically and in life.

An exhaustive review of the literature reveals that the following factors influence the children's numeracy and literacy skills:

- 1. Early Childhood Education:** The interventions provided in early years are cost effective as they minimize the need for special interventions (International Labour Organization, Geneva, 2012,). High-quality preschool and early childhood education programs have been shown to have a lasting impact on children's numeracy and literacy development. Slaby *et al.*, (2005) has highlighted that children who undergo preschool education are better able to acquire the formal mathematical knowledge in school (Slaby *et al.*,2005). Children who are exposed to structured learning environments at a young age are better able to lay a solid basis for future academic success. (International Labour Organization, Geneva, 2012, Qadiri and Manhas, 2017 & Slaby *et al.*, 2005).
- 2. Two Ministries, one mission:** Our education system is currently under the charge of two ministries i.e., Ministry of women & child development and Ministry of education. Preschool education is currently under the charge of Ministry of women & child development, while remaining formal education falls under the purview of Ministry of education (MOE). There is not any alignment between these departments right now (61 code). There should be collaboration between two ministries to create a more comprehensive and integrated approach to education. The collaboration of two ministries with a shared mission can positively impact FLN skills by pooling resources, expertise and strategies. This could help the ministries to streamline policies, ensuring a cohesive and effective implementation of policies that ultimately elevates the overall level of FLN skills.
- 3. Parental Involvement:** Active parental involvement, including reading to children, engaging in math-related activities, and providing a supportive learning environment at home, has a direct and substantial influence on a child's ability to acquire numeracy and literacy skills (Peeler *et al.*, 2012, Lefevre *et al.*, 2002 & Snow and Matthew, 2016). Adults play a crucial role in giving the means to children to engage with a variety of experiences (Wade and Moore, 1998). According to Anderson & Gold (2006), children don't forget what they learn at home from their parents (Anderson and Gold, 2006). Therefore, fostering parental involvement in children learning can contribute to the FLN skills of children.



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4. **Individualized Instruction:** Tailoring teaching methods and materials to individual learning styles and needs can be particularly effective in promoting numeracy and literacy skills. Differentiated instruction allows educators to address each child's unique strengths and weaknesses. Students have diverse learning styles and paces. Individualized instruction takes these differences into account, adapting teaching methods to match the preferences and strengths of each learner, making the learning process more effective (NEP 2020 & NIPUN Bharat, 2021).
5. **Phonemic Awareness and Number Sense:** Children develop preliteracy skills before formal instruction such as print knowledge, oral language and phonological awareness (Purpura and Napoli, 2015). Developing phonemic awareness and number sense in young children lays the groundwork for reading and math success. Effective strategies include phonics instruction, oral language development, and hands-on math activities that foster an intuitive understanding of numbers (Anthony *et al.*, 2007 & NIPUN Bharat 2021).
6. **Literacy-Rich Environment:** Exposure to a literacy-rich environment, where books, writing materials, and a variety of reading materials are readily available, supports language development and encourages a love of reading (NIPUN Bharat, 2021). Such an environment goes beyond traditional classroom instruction, creating a space where literacy is not just taught but is integrated into various aspects of a child's surroundings. A literacy-rich environment also fosters frequent conversations and discussions between teachers and students (Report on state of FLN in India, 2021). This verbal interaction contributes to language development, vocabulary expansion and enhanced communication skills.
7. **Early Intervention and Special Education Services:** Identifying and addressing learning difficulties in numeracy and literacy early is critical. According to Stobie *et al.*, (2004), early intervention is a primary prevention that should be given importance for developing the FLN skills of children (Stobie *et al.*, 2004). Special education services and interventions can provide targeted support to children with specific learning challenges (International Labour Organization, Geneva, 2012, Slaby *et al.*, 2005 & Kumar *et al.*, 2023).
8. **Teacher Training and Professional Development:** It is imperative to provide educators with the requisite competencies and expertise to teach numeracy and literacy skills. Continuous professional development ensures that teachers stay current with best practices (Holmes, 2012 & Igarashi and Suryadarma, 2023). Training helps teachers learn how to differentiate instruction to meet the diverse needs of students. This is crucial for addressing varying levels of proficiency in FLN skills within a single classroom. Furthermore, training programs can equip teachers with the skills to incorporate technology into their teaching practices, leveraging digital tools to enhance literacy and numeracy instruction in engaging and effective ways (Report on state of FLN in India, 2023 & Akhila Bharatiya Shiksha Samagam report, 2023).
9. **Technology Integration:** Appropriately integrated technology, such as educational apps and interactive learning platforms, can engage children in meaningful learning experiences and enhance their numeracy and literacy skills (Ahmad & Gul, 2022, NEP 2020). Digital platforms often include interactive features, such as audio narration, embedded dictionaries and multimedia elements, which can support comprehension and vocabulary development. While technology integration offers significant benefits, it's important to strike a balance and ensure that screen time complements, rather than replaces, other important aspects of learning. Additionally, teacher guidance and support are crucial to maximize the positive impact of technology on FLN skills (Saikia, 2023).
10. **Social and Emotional Development:** A child's social and emotional well-being plays a significant role in their capacity to learn. Positive relationships, self-regulation skills, and a growth mindset contribute to a child's overall readiness to acquire numeracy and literacy skills. Children who have a positive emotional environment are more likely to engage in language-rich activities. Emotional support from caregivers fosters a sense of security, which is essential for language development. Additionally, social interactions, such as conversations with peers and adults, contribute significantly to language acquisition (Xiao *et al.*, 2019). Through interactions, children learn new words, sentence structures, and communication skills.
11. **Assessment and Feedback:** Regular assessment helps identify areas that need improvement. Regular assessment create a dynamic and responsive learning environment that addresses the individual needs of students, promotes motivation and guides continuous improvement in teaching and learning strategies. Constructive feedback, along with targeted interventions, ensures that students receive the support they need.



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Additionally, clear and informative feedback helps parents to support their child's learning at home. It fosters a collaborative relationship between parents and educators. The assessment of child competencies should be done at early age so that needed children should be given opportunity for effective individualized instruction (Amukune *et al.*, 2022) and thus can develop the FLN skills.

12. **Adequate investment in Child nutrition:** Malnutrition also affects the children learning process. Children who receive inadequate nutrition are more susceptible to disease and premature death, as well as reduced productivity and job capacity in later life (Brown *et al.*, 2020). According to Krause (2012) the state of malnourishment in the formative years of child, later impacts the educational achievement of the children. A large number of children under three years old suffer from endemic malnutrition (UNESCO, Education for All Global Monitoring Report 2007). Thus, the health and nutrition of children should be prioritized for enhancing the learning especially the FLN skills of children.
13. **School Readiness:** School Readiness is the most significant factor that contributes to the FLN skills of the children. School readiness includes the child readiness for school, the school readiness for children and the readiness of the family and community to promote the best possible early childhood development (High, 2008 & NIPUN Bharat, 2021). There is a need to boost the school readiness of children, schools, parents and communities for enhancing the FLN skills of the children.
14. **Inadequate research on FLN:** Based on our Knowledge, there are very fewer studies conducted on FLN in Indian context. For instance study done by Bhalotra & Zamora (2006); Alwani (2009) and some others studies have highlighted the FLN skills of children in India. Without thorough investigation, it's challenging to identify the most impactful methods, curricula, and interventions. This lack of understanding may lead to misguided policies and resource allocations, ultimately impeding the improvement foundational skills. Therefore, the researchers should be encouraged to conduct the researches in this area for identifying effective teaching methods and informing educational policies.

The factors affecting FLN skills are diverse and it is important to address these multifaceted factors through inclusive educational policies, promoting parental involvement and enhancing the quality of early education. These can collectively foster the development of robust FLN skills, paving the way for academic success and lifelong learning. Above all, understanding the theoretical perspectives can help the teachers in the development of FLN skills.

Contributions of the study

The contributions of the study are presented in two parts. In the first part, the investigators have presented the overarching theoretical perspectives that would help the educators in the development of FLN skills among children. In the second part, the investigators have highlighted the important implications for the practice on the basis of present study.

Overarching Theoretical Perspectives

Several overarching theoretical perspectives guide the understanding and development of FLN skills. These perspectives provide insights into how individuals acquire these skills and how educators can design effective instructional strategies.

Constructivism

- *Principle:* Learning is an active, constructive process where individuals build knowledge based on their experiences and interactions with the environment (Shah, 2019 and Tuncel & Bahtiyar, 2015).
- *Application:* In the context of foundational literacy and numeracy, constructivism emphasizes hands-on experiences, problem-solving, and real-world applications to help learners actively construct their understanding of language and mathematics.

Socio-Cultural Theory

- *Principle:* Learning is a social and cultural activity, and individuals develop cognitive abilities through interactions with others and cultural tools (Bruce & Hughes, 2011).





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- *Application:* Socio-cultural theory highlights the importance of social interactions, collaborative learning, and the cultural context in the development of literacy and numeracy skills. Language and mathematical concepts are often learned and reinforced through social exchanges and shared activities.

Zone of Proximal Development (ZPD)

- *Principle:* The ZPD, proposed by Lev Vygotsky, refers to the difference between what a learner can do independently and what they can achieve with guidance and support (Fani & Gahemi, 2011).
- *Application:* Educators can apply the ZPD in literacy and numeracy instruction by providing appropriate levels of challenge and support. Tasks that are just beyond a learner's current level of mastery, but achievable with assistance, promote skill development.

Cognitive Load Theory

- *Principle:* Cognitive load is the term used to describe the mental effort needed to learn. Cognitive Load Theory suggests that working memory constraints should be taken into account while designing the instructional materials. (Jong 2010).
- *Application:* In foundational literacy and numeracy, educators should design learning experiences that manage cognitive load effectively. Breaking down complex tasks, providing clear explanations, and offering scaffolding can help reduce cognitive load and enhance learning.

Information Processing Model

- *Principle:* The Information Processing Model views the mind as a computer-like system that processes information through stages, including input, processing, storage, and retrieval (Mohanty, 2015).
- *Application:* In the context of literacy and numeracy, this model emphasizes the importance of encoding information (e.g., phonics rules or mathematical procedures), storing it in memory, and retrieving it when needed for tasks such as reading or problem-solving.

Ecological Systems Theory:

- *Principle:* Proposed by Urie Bronfenbrenner, this theory emphasizes the impact of various environmental systems (microsystem, mesosystem, exosystem, and macrosystem) on human development (Ettetal & Mahoney, 2017).
- *Application:* Ecological Systems Theory highlights the influence of family, school, community, and cultural factors on literacy and numeracy development. Effective interventions should consider the broader context in which learning takes place.

Critical Pedagogy

- *Principle:* Critical pedagogy emphasizes the role of education in challenging and transforming social inequalities (Ettetal & Mahoney, 2021).
- *Application:* In the context of foundational literacy and numeracy, critical pedagogy encourages educators to address issues of equity and social justice. This perspective emphasizes inclusive and culturally responsive teaching practices to ensure that all learners have equal opportunities to develop essential skills.

These theoretical perspectives offer valuable frameworks for understanding how individuals acquire FLN skills and how educators can create optimal learning environments. Combining insights from these perspectives can inform instructional practices that address the diverse needs of learners and foster the development of essential skills in language and mathematics.

Implications for Practice

The researchers have drawn following implications on the basis of present study:

- Practitioners should focus on designing integrated curricula that seamlessly weave together literacy and numeracy skills. This holistic approach ensures that learners see the interconnectedness of these foundational skills, promoting a more comprehensive understanding.



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- Recognizing the importance of early intervention, educators and policymakers should invest in programs that identify and support students with literacy and numeracy challenges at an early stage (Stobie *et al.*, 2004). This may involve targeted interventions, extra resources, and specialized training for educators.
- Practitioners should explore and incorporate technology tools that support foundational literacy and numeracy. Educational apps, interactive software, and digital resources can engage students and provide personalized learning experiences (Ahmad & Gul, 2022, NEP 2020) .
- Continuous professional development opportunities should be provided for educators to enhance their knowledge and skills in teaching FLN (Holmes, 2012 & Igarashi and Suryadarma, 2023). This includes staying updated on effective instructional strategies and incorporating the latest research findings into their teaching practices.
- Encouraging parental involvement and community support is essential (Wade and Moore, 1998) . Schools should develop initiatives that educate parents about the importance of foundational literacy and numeracy, providing resources and activities for families to engage in at home.
- Establishing collaboration among educators, administrators, policymakers, and community stakeholders is vital for creating a supportive ecosystem for foundational literacy and numeracy. This collaboration can facilitate the sharing of best practices, allocation of resources, and the development of a cohesive educational strategy.
- Education leaders should encourage a culture of research-informed decision-making, where policies and practices are guided by the latest research in FLN. This ensures that educational interventions are evidence-based and have a higher likelihood of success.

CONCLUSION

In conclusion, the development of FLN skills in children is a crucial building block for their future academic and life success. Several key factors play a significant role in enhancing these skills. Firstly, a supportive and enriching home environment that fosters a love for reading and mathematical exploration is paramount. Secondly, high-quality early education programs and dedicated teachers who employ engaging and age-appropriate instructional methods can make a substantial difference. Additionally, parental involvement, consistent practice, and personalized learning strategies tailored to a child's unique needs contribute to their success in these fundamental areas. Lastly, fostering a growth mindset, where children are encouraged to persevere and view challenges as opportunities for growth, is pivotal. By recognizing and nurturing these factors, we can ensure that children are well-equipped with the FLN skills they need to excel in school and beyond, opening the door to a lifetime of learning and achievement.

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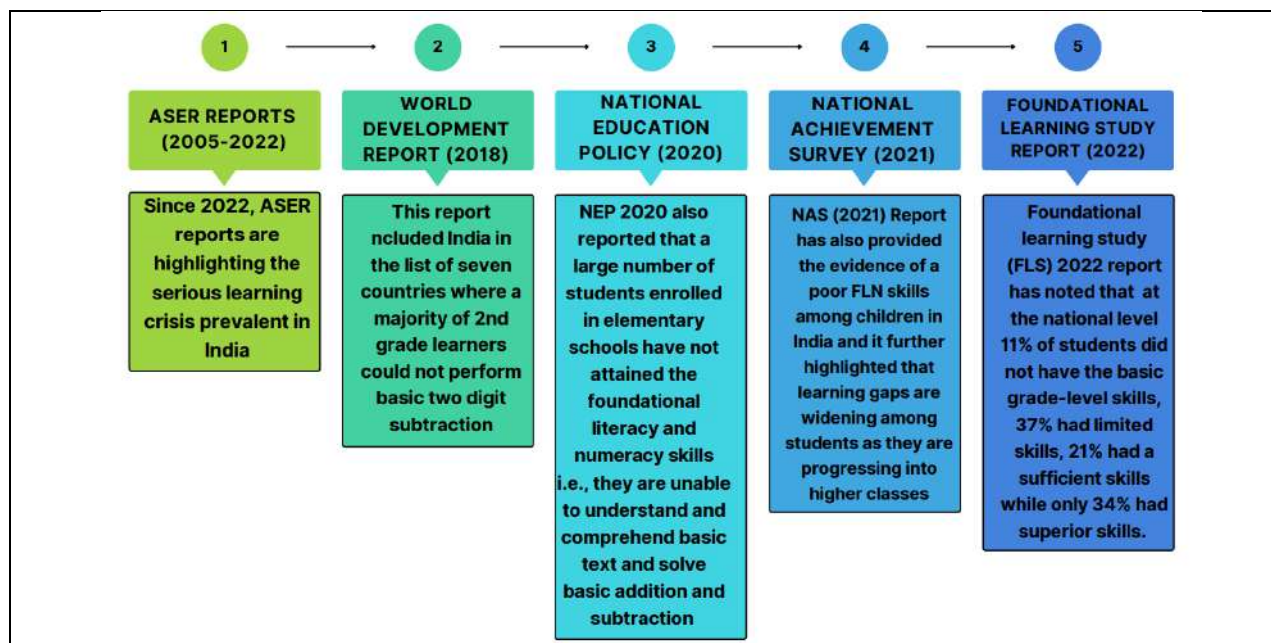


Figure 1: Present Status of FLN Skills in India

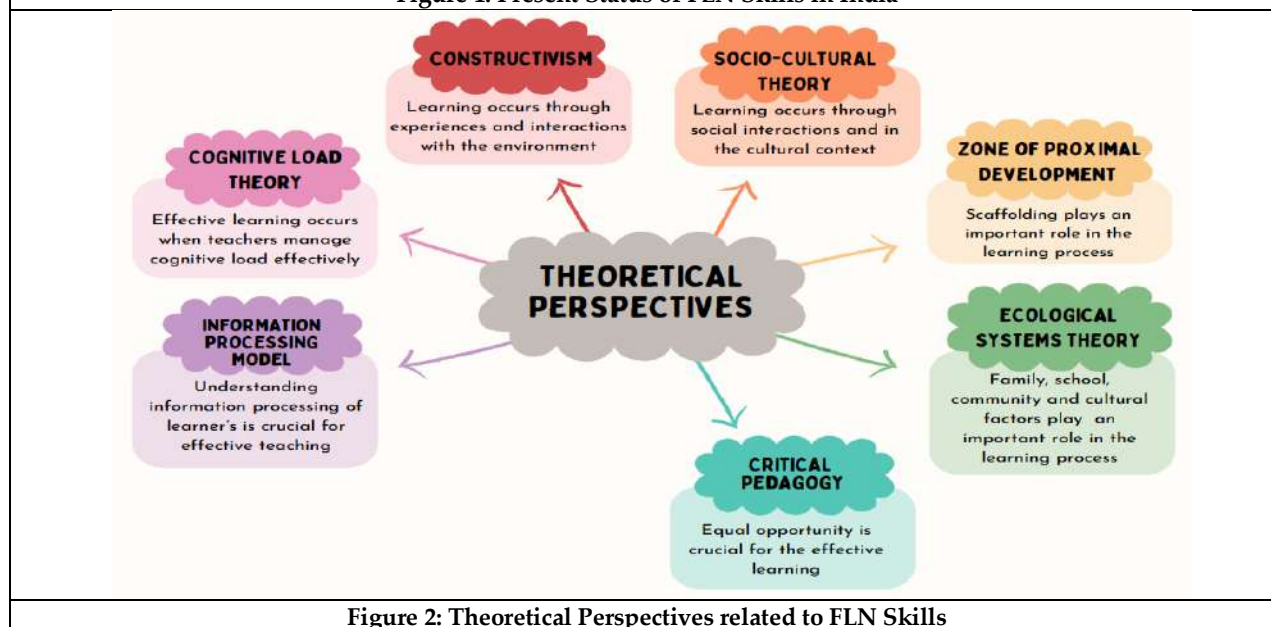


Figure 2: Theoretical Perspectives related to FLN Skills





RESEARCH ARTICLE

Comparative Clinical Evaluation of Onset and Duration of action of Inferior Alveolar Nerve Block of 4% Articaine and 2% Lidocaine with and without Buccal infiltration in Patients with Irreversible Pulpitis in Mandibular Molars

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ABSTRACT

To evaluate the anesthetic efficacy and compare the onset and duration of action of pulpal anesthesia of 2% lidocaine and 4% articaine both with 1: 100,000 epinephrine for inferior alveolar nerve block with and without buccal infiltration in mandibular molars. Forty adult patients aged between 15 to 45 years with irreversible pulpitis in mandibular molars were selected and divided into 4 study groups by random allocation who received IANB of either 4% articaine or 2% lidocaine with and without buccal infiltration. Response to anesthesia was checked after 1.5min, 2.5min, 3.5 min, and 4.5 min along with its onset and after 30 min, 45 min, 60 min and 90 min along with its duration of action using Visual Analogue Scale. Endodontic access was then carried out. Statistically significant results were obtained while comparing pain, duration and onset of action of 4% articaine and 2% lignocaine. Articaine with buccal infiltration has faster onset as compared to lidocaine with buccal infiltration and has longer duration of action compared to lidocaine.

Keywords: 4% articaine, 2% lignocaine, local anesthetics, mandibular molars, inferior alveolar nerve block



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INTRODUCTION

Symptomatic irreversible pulpitis is the most common cause of dental pain that forces patients to seek dental consultations. After confirming the diagnosis of pulpitis, dentists primarily attempt to relieve pain before performing endodontic treatment. The inferior alveolar nerve (IAN) block is the most commonly used mandibular injection technique for achieving local anesthesia for endodontic treatment. However, the inferior alveolar nerve block does not always result in successful pulpal anesthesia. Clinical studies in endodontics (1–4) have found failure with the IAN block occurring between 44% and 81% of the time. Therefore, it would be advantageous to improve the success rate of the IAN block in endodontics. Articaine was introduced in April 2000 in the United States and it is most commonly used dental anesthetic in Germany, Italy, The Netherlands, and Canada. Articaine is classified as an amide and contains a thiophene ring instead of a benzene ring like other amide local anesthetics (5). A second molecular difference between articaine and other amide local anesthetics is the extra ester linkage incorporated into the articaine molecule (5), which results in hydrolysis of articaine by plasma esterases. Isen (6) states that 90% to 95% of articaine is metabolized in the blood, whereas only 5% to 10% is broken down in the liver. The plasma half-life has been reported to be as low as 20 min (7, 8). Articaine is a safe, local anesthetic. A number of studies (5, 9–16) have evaluated articaine and have concluded that it is safe when used in appropriate doses. Both lidocaine and articaine have the same maximum milligram dose of 500 mg (recommended dose, 6.6–7 mg/kg) for the adult patient (17). Because articaine is marketed as a 4% solution, the manufacturer's maximum recommended dose for a healthy 70-kg adult is 7 cartridges of an articaine solution compared with 13 cartridges of a 2% lidocaine solution (17). Lidocaine, synthesised in 1943, was the first amide anaesthetic (18). In the UK, lidocaine remains the most popular local anaesthetic, with over 20 million cartridges sold in 2008 alone. However, this figure is down from nearly 35 million cartridges in 1998, which corresponds with the increasing popularity of articaine (19). The inferior alveolar nerve block (IANB) is common practice for anaesthetising mandibular molars and/or premolars on one side of the jaw. Achieved by depositing local anaesthetic solution at the entrance to the mandibular canal, it inhibits the transmission of action potentials along the inferior alveolar nerve towards the central nervous system (20). This is very technique sensitive. While the IANB remains the first choice for anaesthetising mandibular molars, with some studies reporting success rates of approximately 92%, 8 others suggest that up to 45% of IANBs fail. The buccal infiltration (BI) is most commonly used to anaesthetise individual teeth. Traditionally, this technique is used to anaesthetise the maxilla and the anterior mandible. Infiltration anaesthesia may be successful in up to 100% of cases in the maxilla regardless of whether articaine or lidocaine is administered (21). However, for the posterior mandible, the success rate is between 48% and 76% (when using articaine). The purpose of this prospective, randomized, double-blind study was to compare the anesthetic efficacy, onset and duration of action of 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:100,000 epinephrine for inferior alveolar nerve blocks with and without buccal infiltration in patients, with mandibular posterior teeth, experiencing irreversible pulpitis.

MATERIALS AND METHODS

Forty adult subjects who were in good health and were not taking any medications that would alter their perception of pain were chosen for the study. Subjects who were younger than 18 years or older than 40 years, were allergic to local anesthetics or sulfites, were pregnant, had a history of significant medical conditions, were taking any medications that could affect anesthetic assessment, had active sites of pathosis in the area of injection or were unable to give informed consent were excluded from the study. Written informed consent was obtained from each subject before enrolling him or her in the study. To qualify for the study, each patient had a vital mandibular posterior tooth (molar or premolar), was actively experiencing pain, and had a prolonged response to cold testing with Endo-Ice (1,1,1,2 tetrafluoroethane; Hygenic Corp., Akron, OH). Therefore, each patient had a tooth that fulfilled the criteria for a clinical diagnosis of irreversible pulpitis. Each patient rated his or her initial pain on a Heft-Parker Visual Analogue Scale (VAS) (Fig. 1) (22). The VAS was divided into four categories. No pain corresponded to 0 mm. Mild pain was defined as > 0 mm and < 54 mm. Mild pain included the descriptors of faint, weak, and mild pain.



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Moderate pain was defined as >54 mm and <114 mm. Severe pain was defined as ≥ 114 mm. Severe pain included the descriptors of strong, intense, and maximum possible. The 40 patients randomly received 1.8 ml of 4% articaine with 1:100,000 epinephrine (Septocaine, Septodont Inc., New Castle, DE) or 1.8 ml 2% lidocaine with 1:100,000 epinephrine (Xylocaine, AstraZeneca LP, Dentsply, York, PA) with and without buccal infiltration using a conventional inferior alveolar nerve block. Each patient was randomly assigned a five-digit random number to determine which anesthetic solution was administered. A single operator administered all the injections. Under sterile conditions, the articaine and lidocaine solutions were prepared each day of the appointment by drawing 1.8 ml of the appropriate anesthetic solution into 3-ml Luer-Lok disposable syringes equipped with aspirating ring assemblies (Septodont). The anesthetic solutions were obtained from commercial 1.8-ml cartridges. The appropriate five digit random number was placed on a label, which was affixed to the outside of the Luer-Lok syringe.

Only the random number was used on the data collection sheets to further blind the experiment. Topical anesthetic gel (20% benzocaine, Patterson Dental Supply, Inc., St. Paul, MN) was passively placed at the IAN injection site for 60 s using a cotton-tip applicator. A standard inferior alveolar nerve block (23) was administered with a 26 \times 1 1/2 - gauge, 1 1/2- inch needle (Hindustan syringes and medical devices Ltd Faridabad India) using each anesthetic solution. After needle penetration towards the target site, aspiration was performed and anesthetic solution was deposited at the rate of 1ml/ min. VAS values were noted at 1.5 min, 2.5 min, 3.5 min & 4.5 min post injection, under rubber dam isolation. Access cavity was then performed and anesthetic efficacy, Onset and duration of action was determined. To calculate the duration of action VAS values were noted at 30min, 45 min, 60 min and 90 min. Patients were instructed to definitively rate any pain felt during the endodontic procedure. If the patient felt pain, the treatment was immediately stopped and the patient rated their discomfort using the Heft-Parker VAS. The success of the IAN blocks was defined as the ability to access and instrument the tooth without pain (VAS score of zero) or mild pain (VAS rating 54 mm) Comparisons between the articaine and lidocaine solutions for onset, duration of action and anesthetic success were analyzed using the Student t test and ANOVA. Comparisons were considered significant if $p < 0.05$ and data was graphically represented using a bar diagram.

Statistical analysis

The data collected was analyzed and recorded in preformed per-forma. All the data was then summarized into an excel sheet and analysis was done using SPSS software version 20.0 (IL, CHICAGO, USA). Descriptive data was analyzed using frequency, percentage, mean standard deviation and standard error. Student t was done to analyze and compared continuous variables. The p-value was two tailed and statistically significant at or less than 0.05 values. The data was graphically represented using a bar diagram.

RESULTS

On evaluating the results, of onset of action, the sites with 4% articaine presented positive subjective and objective symptoms within 2.5 minutes of administration of local anesthesia. 2 sites presented positive symptoms within 2.5 minutes, 5 within 3.5 minutes and remaining 3 sites within 4.5 minutes. In case of 2% lignocaine the onset of action started within 3.5 minutes, with positive 4 sites and remaining 6 sites at 4.5 minutes. Thus, representing the shorter onset of action with sites administered with 4% articaine (with buccal infiltration)(Table 1). On comparison within the two groups a statistically significant result was obtained. When comparing the duration of action among the sites administered with 4% articaine and 2% lignocaine with buccal infiltration statistically significant results were obtained at an interval of 90 minutes. The shorter duration of action was found with 2% lignocaine, as 5 sites representing fading away of anesthesia within 60 minutes of the administration. (Table 2). There was no significant difference between the onset, duration of action and anesthetic efficacy of 4% articaine and 2% lidocaine without buccal infiltration. Table 3 represents the pain scores of patients obtained after anesthesia (both immediately after administration and after completion of the procedure). Statistically significant result were obtained on comparing pain score with 0 and 2, as maximum number of patients indicated 0 and 2 scores of pain after the administration of the anesthesia.





DISCUSSION

Articaine is amongst the second most commonly used local anesthetic agent in dental practice. It is known for providing a pulpal anesthesia of more than 1 hour and soft tissue anesthesia of 2.25 hours. Articaine is found to be distinctive from other amide local anesthetic due to its unique chemical nature which contains thiopentene ring instead of hexagonal benzene ring. Being the safest of all the anesthetics due to its immediate metabolic rate, it is prone to decrease the risk of over dosage and systemic toxicity(24). When compared, lignocaine is the most frequently used local anesthetic, which is considered as to be the referral base to evaluate the efficiency of different other local anesthetics. It is known to provide a pulpal anesthesia of 1 hour with soft tissue anesthesia of >3 hours(24). Articaine has been found to be equally or even more efficient than lignocaine since its introduction (25). The present study was conducted to evaluate the efficacy of two local anesthetics on pain and comparison was done between the onset and duration of action of anesthesia. Statistically significant results were obtained when 4% articaine and 2% lignocaine with buccal infiltration were compared. On evaluating the onset of action 4% articaine presented with shortest onset of 2.5 minutes while 2% articaine with buccal infiltration had an onset of 3.5 minutes. This was in consistent with various studies conducted by a number of authors like Kunal Kumar et al., (26) Moore et al., (27) Colombia et al., (28) Gregoria et al. (29) where they stated that onset of action of 4% articaine was shorter than that of 2% lignocaine. Duration of anesthesia is directly proportional to the degree of protein binding; nonetheless, the duration is dependent on the injection site and the concentration of vasoconstriction present in the anesthetic solution including other factors. The duration of anesthesia in case of Group A was longer than Group B.

The findings of the present study was in consistent with Harveen et al. where they concluded that 4% articaine was found to had significantly more duration of action when compared to 2% lignocaine(30). In 2005, Costa et al. (31) conducted a similar study where they stated that 4% articaine clinically presented the longest duration of action, which was further conducted by Haas et al.(32) and Vahatalo et al. (33). In another study done to compare the anesthetic efficacy of 4% articaine and 2% lignocaine by Sree Kumar et al. concluded that 4% articaine had better duration of action along with anesthetic efficacy (34). Some studies have assessed the parameters of onset and duration in maxillary infiltration (31,35) while others, although assessing onset in IANB, did not use an electric pulp stimulator (36,37). A few studies investigated articaine in IANB using an electric pulp stimulator to measure pulpal anesthesia onset and duration periods (27,38). However, these authors (27,38) compared articaine solutions containing epinephrine (1:100,000 and 1:200,000), but not with lidocaine solution containing epinephrine (1:100,00). The results of these studies indicate that pulp onset periods, 7.4 and 7.7 min, for the two articaine solutions were not influenced by different epinephrine concentrations, 1:100,000 and 1:200,000, respectively. The onset values of pulpal anesthesia were higher than those found by Moore et al. (27) (4.2 and 4.7 min) and close to those found by Tofoli et al. (21) (7.0 and 8.0 min) with epinephrine concentrations of 1:100,000 and 1:200,000, respectively. In both studies (27,38), no statistically significant differences were found between onset values of pulpal anesthesia for both articaine solutions with different epinephrine concentrations.

CONCLUSION

Within the limitations of the study it can be concluded that, 4% articaine with 1:100,000 epinephrine with buccal infiltration exhibited faster onset and also had longer duration of pulpal anesthesia when compared with 2% lignocaine with buccal infiltration. Hence, proving articaine with buccal infiltration practically to be more efficient and better anesthetic. Also there was no difference between 4% articaine and 2% lignocaine without buccal infiltration.





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Table 1: Depicting the onset of anesthesia in study patients

Group	Onset of action			
	Frequency/percentage			
	1.5 min	2.5 min	3.5 min	4.5 min
Group A (4% Articaine)	-	2/20	5/50	3/30



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Group B (2% lignocaine)	-	-	4/40	6/60
P- value			<0.000*	<0.000*
Results			Hs	Hs

Table 2: Depicting the duration of action of anesthesia in study patients

Groups	Duration of action			
	Frequency/percentage			
	30 min	45 min	60 min	90 min
Group A (4% Articaine)	-	-	-	10/100
Group B (2% lignocaine)	-	-	5/50	5/50
P- value	-	-	-	<0.000*
Results				Hs

Table 3: Depicting the pain score between the two groups

Groups	0	2	4	6	8	10
	Frequency/ Percentage					
Group A (4% Articaine)	8/80	2/20	-	-	-	-
Group B (2% lignocaine)	6/60	2/20	1/10	1/10	-	-
P- value	<0.000*	<0.000*	-	-	-	-
Results	Hs	Hs	-	-	-	-

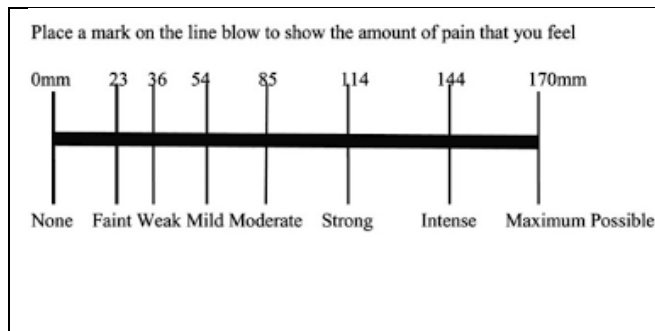


Fig 1: Heft-Parker VAS used for assessment of pain. The millimeter demarcations were not shown on the patients' VAS.



Fig 2: 4% Articaine with 1:100000 epinephrine



Fig 3: Aspirating Dental syringe

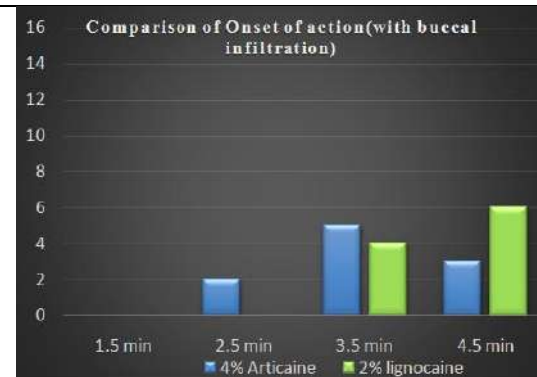
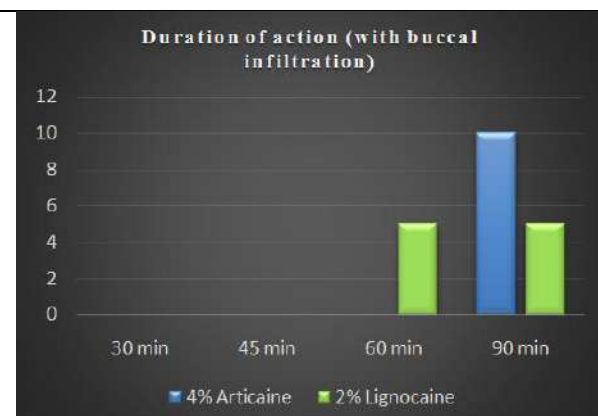
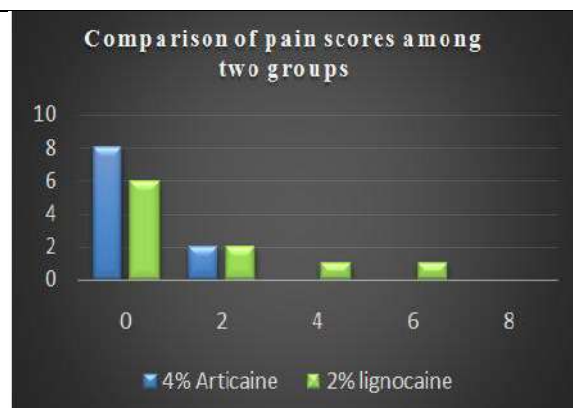


Figure 4: Representing the comparison of onset of action of two groups



**Basawaraj Biradar et al.,****Fig 5: Representing the comparison of duration of action among two groups****Fig 6: Representing the comparison of pain score among two groups**



Fuzzy-Logic-Based AOF Controller for Non-Linear Load in PV-FED Vehicle Application

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ABSTRACT

This work presents an electric power train for PV-fed unmanned aerial vehicles that is based on an intelligent fuzzy logic controller (FLC). A tiny LC filter and an H-bridge inverter with a low switching frequency make up the design. The Active Output Filter (AOF) reduces the weight and size of the power transmission network while also significantly enhancing its conversion efficiency by adding a simulated series opposition with the H-bridge inverter to assure excellent quality sinusoidal signal of the line voltage. The non-linear load causes undesired harmonics, which are reduced by the injected voltage across this simulated series resistance. A fuzzy logic controller-based simulation model was created to simulate the proposed system, and a closed-loop feedback control approach was used to assess the system under non-linear load circumstances. According to the computer simulations, the active resistance compensation approach may be able to produce sinusoidal line voltage waveforms of excellent quality with a THD ratio of around 3%. Additionally, the recommended system's study of power losses and conversion efficiency is performed and contrasted with those of a conventional three-phase PWM inverter, demonstrating a 31% reduction in power losses.

Keywords: PV system, power train, fuzzy controller, Active output filter, LC filter





INTRODUCTION

Reduced weight and size of the electricity framework are the main reasons for using an electric-powered power train framework with a frequency of 400 Hz in aviation packages as opposed to a typical small frequency of 50 Hz [1]. Because of their lower energy force compared to the dynamic energy components, regular channels are perhaps the strongest object in electricity transmission frameworks. As a result, shrinking the size and weight of such channels will unexpectedly reduce the size of the power structure and ultimately lower fuel consumption [2]. A long time has passed since the development of the plane's electric energy education systems, and it has gone through several stages before executing fully automated increasing vehicle UAV innovation. The mechanical primarily based velocity drives, for example, Consistent Velocity Drives (CSD) and coordinated IDG is created to provide mechanical connection points for the 400 Hz simultaneous alternator [3]. The mechanical coupling is largely a variable proportion hydro-mechanical drive that coupled the circulated motor shaft to the coordinated alternator through numerous stuff ranges and water-powered chamber block normal to both the siphon and the engine. Notwithstanding, these mechanical factors of interplay have numerous weaknesses, for instance, low productiveness, it requires incessant and exorbitant upkeep, and significant size and weight [4]. Due to their amazing prospective benefits in energy thickness, high transformation skill ability, and need for less preservation, electric frameworks have replaced bespoke mechanical frameworks in cutting-edge Aeroplan's, which are driven by an increasing number of electric motors [5]. In any case, this involves using several frequencies to operate electric loads. Utilizing a variable speed, constant frequency power train framework, each power train's size, and execution have undergone a significant update. A rectifier, a DC interface, and a PWM inverter with latent (L-C) yield channels are all included in the VSCF power train structure to provide a sinusoidal burden yield voltage. The PWM converter generates the necessary pure voltage on a consistent basis. However, VSCF also has certain drawbacks, such as the PWM converter's lower switching frequency in high electricity programs [6]–[7]. Limitations in the inverter's switching frequency cause the LC yield channel's additives to extend farther and produce a superior final impedance. It moreover improves framework performance in instances with delayed burden [8]. A rural-directed UAV that has been used in a wide range of suggestions, including exchanges, reconnaissance, exams, climatic conditions broadcasting, and leading naval sports, has been made possible by the diligent development in aeronautics power train frameworks [9]. Anyhow, UAVs have a number of difficulties, such as their constant need for oil spinoff when visiting to provide the burning engine for plane propulsion and coffee flying perseverance, short flight times, and sporadic flight endurance. As a result, experts have given solar-based powered UAVs a lot of thought.

MODELLING OF AOF

Figure 1 shows the system under consideration for the power train's implementation. The DC/DC power converter, PV system, power management structure, and battery are the power train's essential components. The six-stage inverter, AOF, and rectifier load make up the AC side. In order to compensate for the rectifier load harmonics, the inverter works at high frequency and injects harmonics. In this article, self-balanced technology is used to increase the DC connection voltage. The voltage waveforms on the DC connection side will be distorted by the current harmonics that the diode bridge rectifier generates. With the aid of AOF, the suggested closed-loop technique transmits the resistance to the harmonics generated by the loads. The main inverter's DC connection voltage and the AOF's common DC link voltage are both taken into account and contrasted. The fuzzy controller receives the error output in order to generate the active compensating resistance brought on by the rectifier load's current harmonics. For the purpose of creating the injected voltage waveforms, the compensation current is multiplied by the line current. The input signal is sent to the AOF with increased switching frequency and a PWM technique after the detected voltage is split with the inserted voltage signals.

SIMULATION RESULTS

The recommended system's simulation results were produced using the MATLAB/Simulink 2018b environment. Figures 3, 4, and 5 show, respectively, the output voltage of the inverter for the open loop, closed loop, and THD waveforms. Figure.6 presents the DC bus voltage, and Figure.7 shows how to compute the AOF's modulation index.





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Figures 8, Figure 9, and Figure 10 show the AOF injected voltage, filter voltage, and nonlinear load voltages, respectively. Figures 11 and 12 respectively show the primary inverter voltages and nonlinear load currents. According on the active filter findings, the suggested fuzzy controller reduces the THD to about 3%.

CONCLUSIONS

In this paper, a new electric energy production system for solar-powered unmanned aerial vehicles (UAVs) is proposed and investigated. It uses a fuzzy logic controller and a live output filter. Balanced DC-hyperlink voltages for AOF have been achieved via closed-loop management of energetic resistance reimbursement, which provides an injected voltage across it to lower undesirable harmonics caused by the non-linear load. The voltage and current waveforms along with the gathered simulation results demonstrated the usefulness and accuracy of the advised strength era system. The active resistance compensation offered guarantees a super sinusoidal line voltage with much less than 3% common harmonic distortion.

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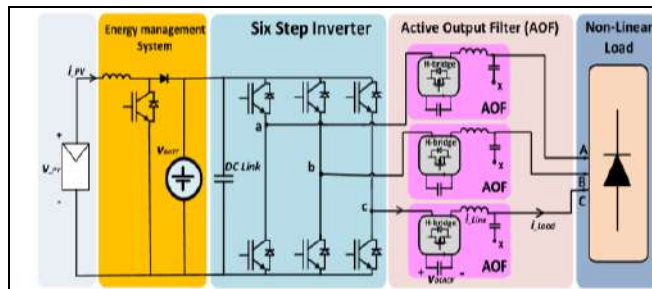


Figure.1: Modelling of AOF

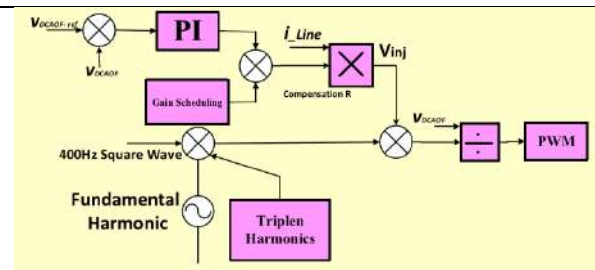


Figure.2: Fuzzy controller

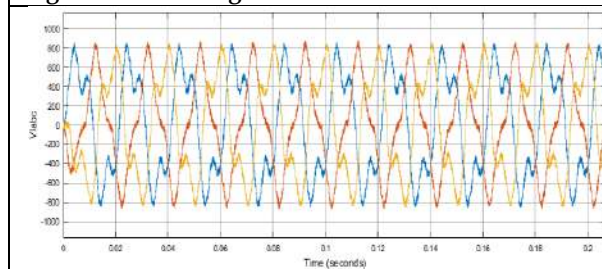


Figure.3: Output line voltage in open loop control

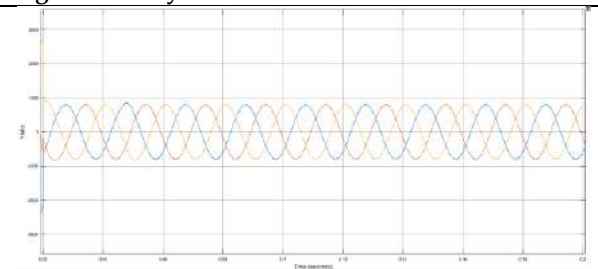


Figure.4: Output line voltages under closed loop fuzzy controller

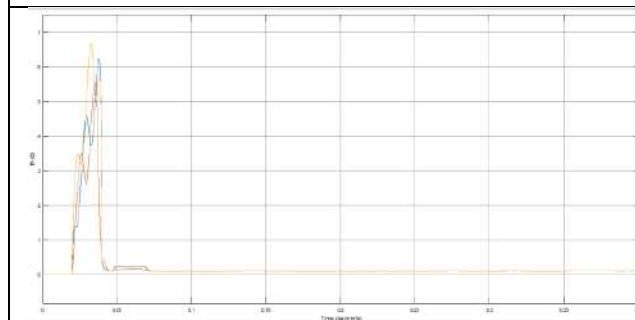


Figure.5: THD of inverter output

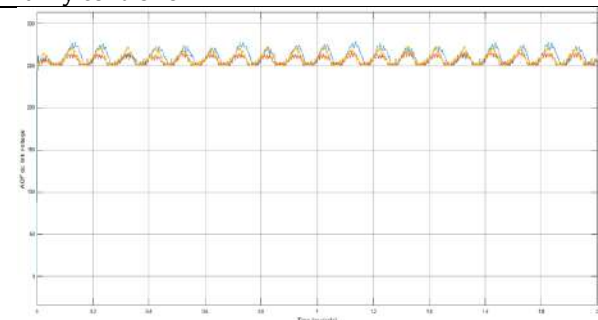


Figure.6: DC-bus voltages

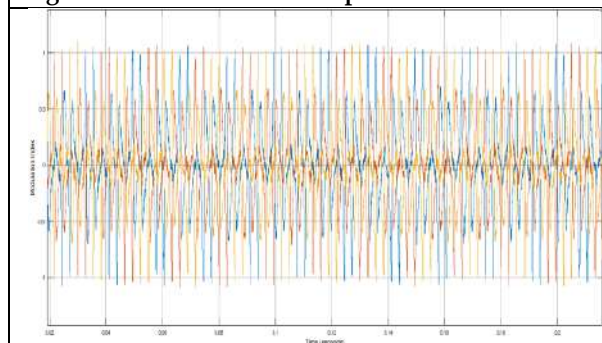


Figure.7: Modulation index of AOF

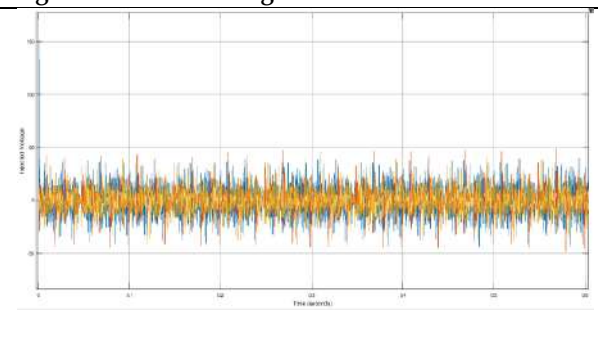


Figure.8: AOF injected voltage





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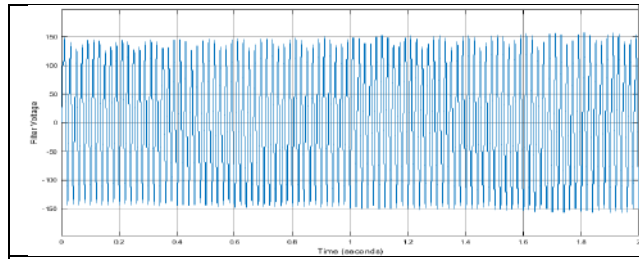


Figure.9: Filter Voltage

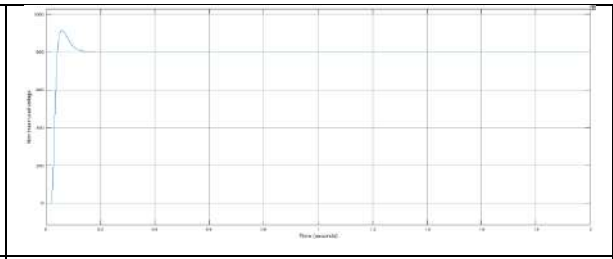


Figure.10: Load voltage

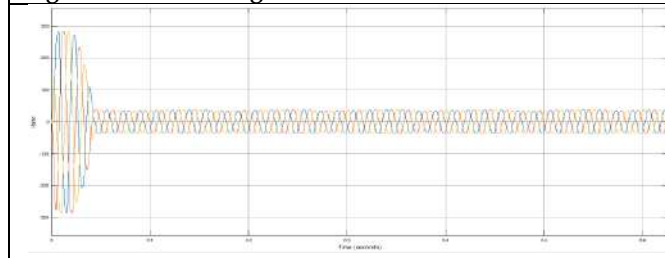


Figure. 11: Non-linear Load currents

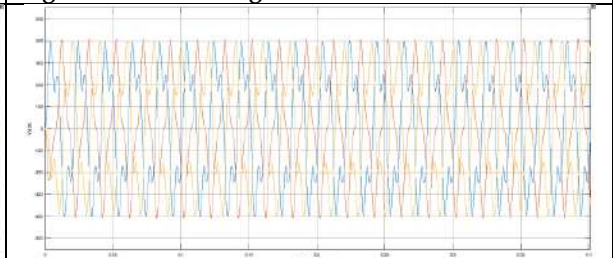


Figure. 12: Main inverter voltages





Groundwater Quality Assessment for Domestic and Irrigation purposes for Mandya district of Karnataka, India using Geospatial tools

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ABSTRACT

Groundwater is extensively needed by most organisms on earth, especially humans. Groundwater depletion and its quality degradation are noticed in various parts of the country due to rise in demography, climate change, global warming, and industrial demands. Similar affects are observed from Mandya district of Karnataka state where 70 water samples are randomly acquired during the pre-monsoon (April 2023) and assessed for 15 parameters quality. SAR, RSC, permeability index, magnesium hazards, sodium percentage, and Kelly's ratio are evaluated for both drinking and agricultural aspects. Anthropogenic activities of modern agricultural practices, mining, and municipal waste dumps releasing toxic effluents into the groundwater that contributing to rise in salinity and alkalinity noticed at some locations of the study district. The outcome results enumerate the above permissible limits of groundwater parameter through spatial representation maps and assess in future management plans for Mandya district.

Keywords: Groundwater Quality, Parameters, WHO, BIS, Mandya.

INTRODUCTION

In India, nearly 2 lakh sq.km area is affected by saline water with EC of more than 4000 $\mu\text{S}/\text{cm}$ and being a prime issue in agricultural practices. Modern type of agricultural practices involves intensive applications of sewage/ drain water, agrochemicals, fertilizers, and mining/ quarrying & automobile services even on minor lineaments cause serious threat to groundwater quality [2]. Many parts of Rajasthan and southern Haryana showed higher value of EC





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values of 10,000 $\mu\text{S}/\text{cm}$ making water sources as non-portable. Most parts of northern districts in Karnataka state showed higher concentration of chlorine, EC, fluoride; where nitrate distribution are higher in almost all districts except few. Among the freshwater sources, groundwater is well utilized by man for his daily needs of domestic, irrigation, mining, automobile industries and other demands. Evaluating both chemical and physical characteristics are much needed to allocate water suitability for various fields. Anthropogenic activity are quicker than rock-water interactions noticed in many parts of the country in affecting groundwater water quality. The chemistry of both surface and subsurface water sources changes over time due to the interactions of geology, soil, meteorology, hydromorphology, and vegetation type. Carbon-di-oxide and other chemical constituents react highly with rainwater over lands and infiltrates through tiny pores to subsurface regions and progressively causing groundwater contamination. Groundwater chemistry changes based on water movement within the pores present between rock present beneath the earth, and residence time also affect it. Irrigation water contains soluble dissolved salts originating from the hydro-geochemical process that increase osmotic pressure which makes plant roots to observe more amounts of water [32]. These salts also affect soil structure, and permeability that ultimately affecting the plant growth. The irrigation water quality is greatly experimented by many earlier pioneers through Residual Sodium Carbonate (RSC), Sodium Absorption Ratio (SAR), Permeability index, Sodium Percentage, Magnesium hazards and Kelly's ratio. Mandya district covering an area of 4,850.8 sq.km and lies in between $76^{\circ}19'$ to $77^{\circ}20'$ E longitude and $12^{\circ}13'$ to $13^{\circ}14'$ N latitude (Fig.1a). The general elevation ranging from 287 to 1045 mts above MSL and sloping towards SE direction. Average annual rainfall records 691 mm and temperature ranges from 16° to 37°C . Cauvery, Shimsha, Hemavathi and Lokapavani are the major flowing rivers in the district that providing main sources of water for irrigation. The district falls under rain shadow zone of Western Ghats and receives most of the rainfall during monsoon seasons.

METHODOLOGY

70 groundwater samples are randomly collected using Garmin GPS etrex-10 handheld instrument from various locations of Mandya district during the Pre-monsoon period (April) of the year 2023 (Fig.1a). The samples are collected using polythene bottle that was cleaned by distilled water rinsed with same water sample at the time of sample collection and carried to laboratory on the same day. Samples are treated with nitric acid for cation analysis and stored under 4°C for anion analysis. The present analysed parameters include fluoride (F^{-}), electrical conductivity (EC), potential of hydrogen (pH), total hardness (TH), iron (Fe), total dissolved solids (TDS) and cation groups like calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), and anions groups like bicarbonate (HCO_3^{-}), carbonate (CO_3^{2-}), sulphate (SO_4^{2-}), chloride (Cl^{-}) and nitrate (NO_3^{-}). EC, pH and TDS are estimated in the field by using Hanna field meter; Ca^{2+} , Mg^{2+} , Cl^{-} are estimated by volumetric titration method; Na^{+} and K^{+} estimated by using Flame Photometer; F^{-} is estimated by visual interpretation technique; whereas SO_4^{2-} is estimated by turbidity method as per BIS Standard (Islam and Patel, 2011; Ramesh and Elango, 2012). The obtained results are correlated and analysed with the help of both World Health Organization (WHO) and Bureau of Indian Standards (BIS) values for better interpretation [5; 34]. The agricultural aspects like SAR, RSC, Permeability index, Magnesium Hazards, Sodium Percentage and Kelly's ratio are also evaluated in the present study. Thematic maps of sample location, agriculture overlaid on lineament, lithology, and spatial distribution maps are generated by ArcGIS v10 software, Wilcox diagram [35], USSL diagram and Piper Diagram are Plotted using Diagrams Software.

RESULTS AND ANALYSIS

Geogenic activity

The study area falls under Western Dharwar Craton and Peninsular Gneiss [24] comprises 3.4-3.0 Ga 'Ancient Supracrustals' (Sargur Group) and tonalite-trondhjemite-granodiorite (TTG) basement overlain unconformably by 2.9-2.6 Ga greenstone belts [23,27]. Gneiss, granite, pegmatite, and ultramafic rock & dykes are the major rock types observed during limited field visits (Fig.1b). Gneiss, granite, amphibolite schist and excess of mica mineral are





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identified near Melukote area. The rainwater infiltrates to ground through small pores and dissolves with various minerals present in the weathered rocks by dissolution, carbonate weathering, ion exchange process and others. This chemical process varies both spatio-temporally by the chemical behaviour geological formation and water. The rock-water interactions are estimated by Gibbs [12] plot for both cations and anions (Fig.2b).

Anthropogenic activity

Paddy, sugarcane, maize, ragi, pulses, vegetables are majorly grown in the district that require huge supply of chemical fertilizers, pesticides and weedicides that causing great anthropogenic activities in Mandya district. Nitrate concentrations are highest among all parameters in most part of the district due to over usage of chemical fertilizer extensively used by farmers. The excess agricultural runoff, municipality waste water are being leached into subsurface zones causing groundwater contamination through major/ minor lineaments (Fig.2a). The farmers in the dry zones of Nagamangala, K.R Pete and Malavalli taluks are highly dependent on groundwater for their agricultural activities. Over utilization of weedicides, pesticides and chemical fertilizers not only affecting the groundwater, but also adversely modifying the soil texture due to modern irrigational techniques.

Groundwater Quality Assessment for Domestic Use

Groundwater used for drinking does not exceed the high amount of minerals and other chemical compounds present in it. The water quality results of standard deviation, mean, maximum, and minimum are given in Table.2. WHO and BIS established a standard permissible limit for chemical parameter for drinking water is prescribed in Table.1. Calcium values vary from 14.4 to 144mg/l and the average is 67.53mg/l and revealing that all water samples are within standards permissible value for both BIS and WHO. Magnesium ranging from 6.4 to 116mg/l and the average is 34.9mg/l depicting that one sample is exceeding the standard permissible values of BIS; while all other samples are in the standard permissible values of both BIS and WHO. Sodium ranges from 21.95 to 276.65mg/l and the average is 68.85mg/l. Potassium ranging from 0.28 to 73.91mg/l and the average is 5.28mg/l. Chlorides vary from 13 to 254 mg/l and the average is 63.48 mg/l and all water samples are within the standard permissible value of BIS and WHO. Bicarbonates vary from 94.9 to 900.3 mg/l and the average is 346.47mg/l. Fluoride varies from 0.2 to 0.6 mg/l, which doesn't exceed standard permissible value of both WHO and BIS. pH varies from 6.7 to 8 in Mandya which does not exceed the WHO and BIS standards and it can be reduced by applying organic acids from decay vegetation matter or by the dissolution of sulfide minerals [3,7]. Nitrates vary from 0.8 to 78 mg/l and the average is 19.27mg/l and seven samples are exceeding the standard permissible value according to WHO and BIS due to the overuse of nitrogen fertilizers for agriculture activities [4]. Sulfate varies from 2.98 to 251 mg/l and the average is 47.82mg/l and all sample values are within the permissible range according to BIS and WHO standards [4]. TH varies from 72 to 725 with an average of 316.02; while TDS varies from 176mg/l to 1562mg/l and the average is 552.92mg/l depicting longer residing time along its flow path [7] with the composition of inorganic salts and small amount of dissolved organic matter. This process increases total dissolved concentrations and major ions that normally occur in nature [20]. The exceeding concentration of higher TDS is unfit for drinking purposes and also causes gastrointestinal irritation. In the study area, 2 samples are above the 1000mg/l is unfit for drinking water, and all other samples are below the 1000mg/l.

Groundwater Quality for Agriculture

Krishna Raja Sagara (KRS) dam release water through number of channels that supply sufficient amount of water for the seasons of rainfall and post-monsoon; whereas for extreme summers the farmers of entire Mandya need to depend on groundwater exploration for irrigational and agricultural practices. This process severely modifying the groundwater chemistry and will certainly affect irrigation water in near future.

EC

It's an important parameter of water chemical quality that will be measured through ionized inorganic salts in solution conducting electric current. EC concentration varies from 291 to 2472 ($\mu\text{S}/\text{cm}$). EC depends on the rock-water interaction and residing time in water [4,11]. The classification of EC results based on the U.S Salinity





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Laboratory guidelines [33] showing excellent to permissible in majority of the Mandya district, except one particular location (Fig.3a; Table.3).

SAR

Sodium hazards are measured by taking into the account of magnesium and calcium content in the collected water sample by using below formula

$$SAR = \frac{Na}{\sqrt{Ca+Mg/2}} \quad (\text{all values in meq/l})$$

The soil structure, its permeability and characteristics property modifies due to increase in sodium content in the soil [17]. The formation of saline soil are noticed due to high salt concentration in water; whereas the development of alkaline soils are observed by high sodium content. All the samples of SAR (<10) in Mandya fall under the Excellent category (Table.4). SAR plotted against the EC in analysing the interaction of various ions that may affect the irrigation water by using USSS [33] diagram (Fig.3b). In figure.3b, the salinity hazards are classified as very high (C-4), high (C-3), medium (C-2) and low (C-1) based on the EC classes of very high (S-4), high (S-3), medium (S-2) and low (S-1). In the study area, 31 samples noticed under suitable category for water usage of group-1 (C1-S1; C2-S1); 38 samples observe under conditional usage of water of group-2 (C1-S2; C2-S2; C3-S1; C3-S2) and only one sample fall under unsuitable water for irrigation category of group-3 (C4-S1) as shown in Table.5.

RSC

It is the difference between the sum of Ca and Mg and the values are expressed in milli equivalents and one among the crucial indicator for assessing groundwater quality for agricultural purposes [1,29]. The formula for calculating the RSC of water is given below:

$$RSC = (CO_3 + HCO_3) - (Ca + Mg) \quad (\text{all values in meq/l.})$$

Nearly 66 number of water samples fall under safe category; 3 are under moderate and only 1 noticed under unsuitable category as given in Table.6.

Sodium percentage

The soil content with high sodium-carbonate association rises the alkali soils with chlorides leading to the soil salinity. The soil permeability reduces due to the reaction of sodium with soil [16]. Sodium percent is important in the classification of irrigation water [21] and is calculated by

$$Na \% = \frac{(Na+K) \times 100}{(Ca+Mg+Na+K)} \quad (\text{all values in meq/l})$$

The sodium percent of all collected samples are observed in permissible (24%), good (48%) and excellent (12%) category (Table.7). Wilcox diagram [35] plotted for sodium percent against EC to study the suitability for the irrigation of water (Fig.4a).

Permiability Index

These are altered due to longer usage of irrigation water as affected by sodium, magnesium, bicarbonate, and calcium content of soil [8]. The permeability can be calculated by using the formula [9,14]

$$PI = \frac{(Na + \sqrt{HCO_3}) \times 100}{(Ca^{2+} + Mg^{2+} + Na)} \quad (\text{All values in meq/l})$$

The permeability index is less than 25% is unfit for irrigation [9]. The classification of irrigation water based on Permiability index Class-1(>75%), Class-2 (25%-75%), Class-3 (<25%) shown in the figure.4b [10, 31]. All the samples of Mandya falls under the Class-1 category that shows good for irrigation.

Magnesium hazard: Magnesium Hazard (MH) value for irrigation water was proposed by [30] using the formula

$$MH = \frac{Mg}{(Ca + Mg) \times 100} \quad (\text{All values in meq/l})$$





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The magnesium hazard content more than 50 is unsuitable for irrigation and effects on crop yield and soil salinity. Magnesium hazard ranges from 10.4 to 81.7 meq/l and 13 samples exceed 50 for Mandya district which is unsuitable for irrigation (Fig.5a).

Kelly's ratio: The suitability of irrigation water is analysed by on Kelly's ratio [16] and the ratio of sodium to calcium and magnesium is determined by

$$KR = \frac{Na}{Ca+Mg} \text{ (all values in meq/l)}$$

Kelly's ratio is less than one suitable for irrigation [15]. The value varies from 0.13 to 1.31 meq/l, and showed less than 1 in Kelly's ratio and suitable for irrigation except well numbers of 31, 32, 40 which is not suitable for irrigation (Fig.5b) [18, 28].

Hydrogeochemical facies

Pipers diagram was plotted in accordance with the concentration of major anion and cation present in the collected water sample (Fig.6) [22]. The hydrogeo chemical facies type of groundwater for Mandya district is identified as Ca-Mg-Cl, Ca-Na-HCO₃, and Ca-HCO₃ types. Ca-HCO₃ (Carbonate) is the superior type of water among the collected samples indicating that the above water type is from the groundwater recharge and return flow of agriculture water [26].

DISCUSSION

Agricultural activities are majorly dependent on groundwater in dry areas of Malavalli, KR. Pete and Nagamangala taluks. Groundwater is the prime source for all sectors in rural areas of Mandya district and it's over utilization has recorded in recent past for irrigation lands that severely modified the soil textures. Higher concentration of nitrates is recorded in major parts of the district by over usage of nitrogen fertilizers [6]. Heavy applications of pesticides, weedicides, and chemical fertilizers had affected the groundwater quality. Few regions of Nagamangala, K.R. Pete and Mallavalli falls under dry zones and studying water chemistry is the prime task for proper water utilization.

CONCLUSION

Mandya district is a part of hard rock terrains of Precambrian rocks that showed longer rock-water interaction time and affecting the groundwater quality. Nitrate concentration showed higher amount among other parameters studied and need proper guidance to the farmers during the usage of nitrogenous fertilizers which may leach to groundwater. Geogenic and anthropogenic activities are the main sources of water chemistry in Mandya and also showed salinity and alkaline issues at certain major locations.

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Table.1. Standard Permissible Limit Analysis for Groundwater Parameters with WHO and BIS

Parameters	WHO standards		Well numbers exceed Permissible limit	B.I.S Standards		Well numbers exceed Permissible limit
	Desirable Limits	Permissible Limits		Desirable Limits	Permissible Limits	
pH	7 - 8.5	6.5 - 9.5		6.5	8.5	
TH (mg/l)	200	600	21	300	600	19, 21, 36, 64, 66
Cl- (mg/l)	200	600		250	1000	
SO ₄ ²⁻ (mg/l)	200	400		200	400	
NO ₃ ⁻ (mg/l)	45	45	11,18,39,68	45	-	11,18,39,68
Ca ²⁺ (mg/l)	75	200		75	200	
Mg ²⁺ (mg/l)	50	150	21	30	100	21
TDS	500	2000		500	1500	21
F-	1.0	1.5		1.0	-	

Table.2. Water quality results of Mandya district

Parameters	Minimum	Maximum	Mean	Standard deviation
F-	0.20	0.60	0.34	0.12
NO ₃ ⁻	0.80	78.95	19.27	19.08
Ca ²⁺	14.40	144.00	67.53	25.45
Mg ²⁺	6.40	111.60	34.90	22.26
Na ⁺	21.95	276.65	68.85	41.08
K ⁺	0.28	73.91	5.28	9.16
SO ₄ ²⁻	2.98	251.00	47.82	44.18
Cl-	13.00	254.00	63.48	51.54
CO ₃ ⁻	0.10	5.49	1.23	0.92
HCO ₃ ⁻	94.30	900.30	346.47	132.35
pH	6.79	8.00	7.50	0.26
EC	291.00	2472.00	883.94	379.72
TH	72.00	725.00	316.02	126.12
TDS	176.00	1562.00	552.92	242.42

Table.3. USDA salinity laboratory Class

TDS (mg/l)	EC in Ms/cm at 25° C	Salinity Class	Potential injury and necessary management for use in irrigation water	Wells, No fall under the Class
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>150	>250	Excellent or Low C1	Low Salinity hazards are generally not a problem additional management is not needed	Nil
150-500	250-750	Good or Medium C2	Medium Salinity hazard damage to salt-sensitive plants may occur. Occasionally flushing with low-salinity water may be necessary	1, 2, 3, 4, 6, 10, 14, 24, 25, 26, 28, 30, 31, 32, 34, 45, 48, 51, 52, 53, 55, 56, 58, 62, 63, 65, 67, 68, 69, 70
500-1500	750-2250	Permissible or High C3	High Salinity hazard damage to plants with low tolerance to salinity will likely to occur. Plants growth and quality will be improved with excess irrigation for leaching or periodic use of low salinity water and good drainage provided	5, 8, 9, 11, 12, 13, 15, 16, 17, 18, 19, 20, 22, 23, 25, 27, 29, 33, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 46, 47, 49, 50, 57, 59, 60, 61, 64, 66
1500-3000	2250-5000	Unsuitable or Very High C4	Very high salinity hazard, damage to plants with high tolerance to salinity may occur. Successful use as an irrigation source requires salt tolerance plants, good soil drainage, and excess irrigation for leaching and periodic utilization of low salinity water.	21

Table.4. Irrigation water quality based on Sodium Absorption Ratio

SAR values	Class of water	No. of Samples
<10	Excellent	70
10-18	Good	-
18-26	Fair	-
>26	Poor	-

Table.5. Classification based on USSL Diagram

Groups	USDA Class	Irrigation Water Class	No of Wells in the Class
Group-1	C1-S1, C2-S1	Suitable to use	31
Group-2	C1-S2, C2-S2, C3-S1, C3-S2	Conditionally suitable	38
Group-3	C1-S3, C1-S4, C2-S3, C2-S4, C3-S3, C3-S4, C4-S1, C4-S2, C4-S3, C4-S4	Unsuitable	1

Table.6. Irrigation water quality based on Residual Sodium Carbonate

Range of RSC	Class	No. of Sample
<1.25	Safe	66
1.25-2.5	Moderate	3
>2.5	Unsuitable	1

Table.7. Classification of irrigation water based on Sodium percent [21]

Sodium Percent	Suitability for irrigation	Well No, fall under class
>20	Excellent	24, 25, 44, 49, 59, 64, 65, 66, 67
20-40	Good	1, 3, 4, 5, 6, 7, 9, 10, 11, 14, 16, 17, 19, 20, 22, 26, 27, 28, 29, 30, 33, 34, 36, 37, 38, 39, 42, 43, 45, 46, 50, 51, 52, 53, 54, 56, 57, 58, 60, 61, 62, 63, 68, 69





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40-60	Permissible	2, 8, 12, 13, 15, 18, 21, 23, 31, 32, 35, 40, 41, 47, 48, 55, 70
60-80	Doubtfull	-Nil-
>80	Unsuitable	-Nil-

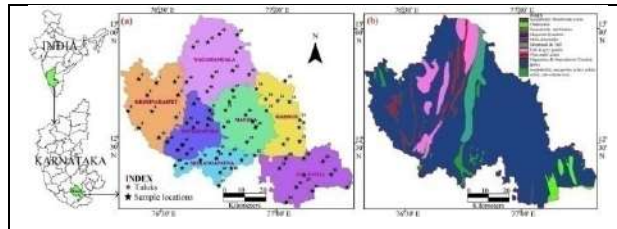


Fig. 1. (a) Sample location map; (b) Lithology map of Mandya district

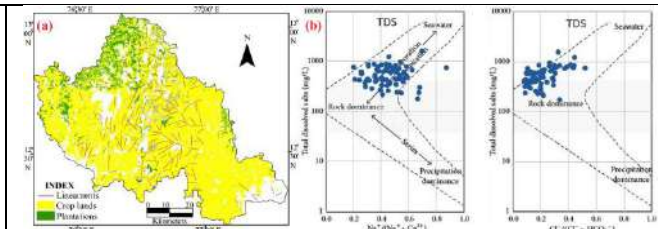


Fig.2 (a) Lineaments overlaid on agricultural lands; (b) Gibbs Plot showing Rock-Water Interaction as main process governing groundwater chemistry

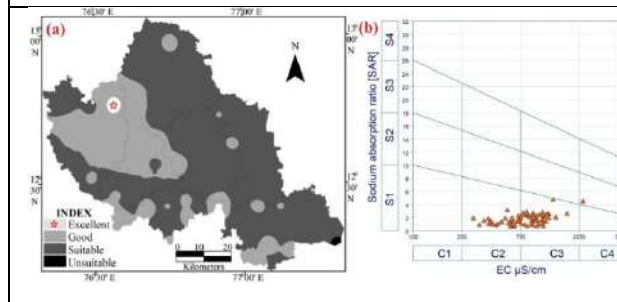
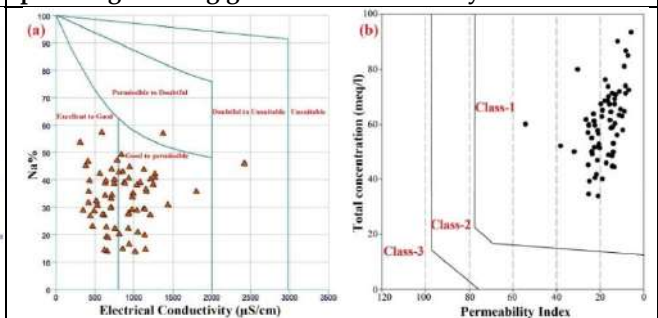
Fig.3. (a) Spatial distribution of EC ($\mu\text{S}/\text{cm}$); (b) USSL Diagram classifying the Water for irrigation

Fig.4. (a) Wilcox Scatter diagram EC v/s Sodium percent; (b) Doneen Classification of irrigation water based on Permeability Index

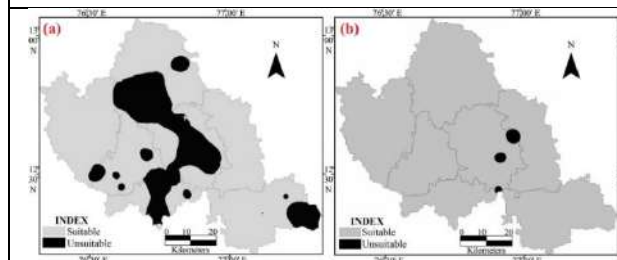


Fig.5. (a) Spatial variation of Magnesium Hazard; (b) Kelly's Ratio

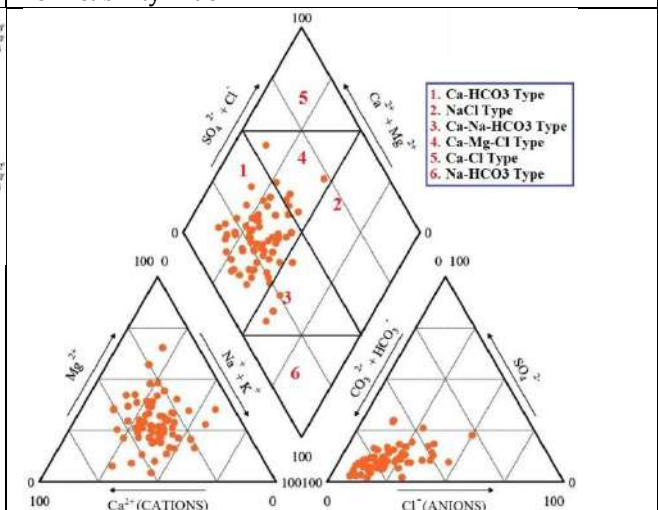


Fig.6. Piper's Diagram showing hydrogeochemical facies





Analysis of Methodologies used in ECG Data Processing for Arrhythmia Detection - A Research Perspective

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ABSTRACT

Non-stationary signal electrocardiogram (ECG) is commonly used to measure the rate and regularity of heart beats. An electrocardiogram gauges the electric movement of the heart and has been generally utilized for identifying heart infections because of its effortlessness and harmless nature. By breaking down the electrical sign of every heartbeat, i.e., the blend of activity motivation waveforms created by various specific cardiovascular tissues found in the heart, recognizing a portion of its abnormalities is conceivable. The comparison of the overall pattern and shape of the ECG waveform allows physicians to diagnose possible diseases. There is currently a computer-based analysis that uses some signal processing to diagnose a patient on the basis of an ECG recording. The efficacy of the ECG reported is substantially limited by noise and therefore needs to be removed for better clinical evaluation. The extraction of ECG features is also required because it plays a vital role in the diagnosis of most heart diseases. Recently, a few works were created to deliver programmed ECG-based heartbeat grouping strategies. In this work, we study the present status of-the-craftsmanship strategies for ECG-based computerized anomalies heartbeat characterization by introducing the ECG signal pre-processing, the heartbeat division procedures, the component depiction techniques and the learning calculations utilized. Databases used to test the different methods developed by the researchers were also discussed. Finally, the drawbacks and limitations of the approaches are discussed and the paper concludes with findings and possible challenges.





Keywords: ECG, feature extraction, ECG signal analysis.

INTRODUCTION

An Electrocardiogram (ECG) is essentially a snapshot of heart-generated electrical activity [1]. Figure 1 represents a cardiac cycle and its related waves. A period of normal ECG [2] signal is pictured in figure 2. The ECG is an important device used in numerous biomedical applications, viz., heart rate calculation, observation of the rhythm of heartbeats, detecting disorders in heart, emotion detection and identification of biometrics. ECG analysis is very much required in detecting cardiovascular diseases (CVD). World Health Organisation (WHO) reported that the CVDs are the key cause for deaths internationally. Cardiac arrhythmias are the most common in CVDs. As a result, in biomedical research, the particular classification is of great significance [3]. For the automated identification of an ECG pattern, the examination of individual characteristic types of heart beat, morphological characteristics, and spectral post-sessions may provide dramatically associated clinical knowledge. The automated way of classifying the ECG signals is more problematic, since, under different therapeutic circumstances, the structural and sequential properties of ECG signals provide major differences between several patients [4]. The main issue with the diagnosis of heart disease is that different patients have distinct ECG morphologies. In addition, two separate pathogens may have roughly the same characteristics. The difficulties in detecting the heart disease are caused by these complications [5,6]. To detect heartbeat irregularities, the electric heartbeat must be tested. The method of evaluating the ECG records over a long time that includes the monitoring over the bedside or by any wearable device, can be very problematic for a person and it is a time-consuming process [7]. In addition, failure or errors can occur due to fatigue, and profound understanding is needed for signal interpretation [8]. Computer-assisted approaches are also used to implement automated ECG analysis.

Rather than the cardiovascular disease diagnosis, the usage of ECG analysis in other fields has increased tremendously. Many researchers use ECG signals to recognise emotions, particularly to detect stress levels. They assess ECG symptoms at different critical moments (stress) such as oral review, student breaks, school workers' employment environments and passenger driving tasks. The findings of these studies reveal that the ECG features are useful in recognising the characteristics of different mental workloads and levels of stress. ECGs in the field of biometric identification are becoming more popular nowadays. In biometric authentication, physiological characteristics such as patterns, fingerprints, hand geometry, DNA and iris and behavioural features such as voice, gasp, signature and keystroke mechanics are used to identify a person. Biometric systems [9] help security and exclusive access to secure areas. The characteristics to be used in this regard must meet the requirements of universality, uniqueness, longevity and robustness of the attack. Due to its unusual or unique characteristics, many researchers are doing continual research in the field of ECG[10].

Datasets

Various databases consist of cardiac beat grouped in freely accessible patient records which enable the standardisation of the automatic arrhythmia classification methods to be established. The standardizations were developed by AAMI and defined in the ANSI / AAMI EC57:1998/(R)2008 protocol to confirm the assessments for reproducibility and comparability of the experiments. Standardization suggests the use of below databases:

Name of the Database	Number of Recordings
MIT-BIH: Massachusetts Institute of Technology-Beth Israel Arrhythmia Hospital Database	48 records for every 30 minutes
EDB: ST-T European Cardiology Society Database	90 instances/records of 2- hours each
AHA: American Heart Association Database for Ventricular Arrhythmia Detector Assessment	80 reports of each 35 minutes
CU: The Continuous Ventricular Arrhythmia Archive of	35 records of 80 minutes each





Creighton University	
NST: Noise Stress test database	12 ECG records of 30 minutes each plus 3 noise excess records
Proposed Method	125 24-hour ambulatory ECG Recordings from a mixed population of patients

LITERATURE SURVEY

The literature survey is conducted with the purpose of identifying the latest methodologies used in ECG data processing for the detection of arrhythmia. It has been noticed that a lot of work has been done in this field. Figure 3 displays the basic architecture for ECG signal processing. Langley et al. [11] developed an algorithm for evaluating morphological changes based on the PCA (Principal Component Analysis), which was employed to obtain single-lead ECG replacement respiratory signals. The PCA explains the respiratory variability of ECG, P waves, QRS complexes and T waves characteristics. Breathing was extracted from the ECG signals with the aid of the RR and QRS-based algorithms. The ECG-derived respiration was correlated with the observed respiratory signal by magnitude squared coherence and cross-correlation. Coherence and correlation were found to be $p < 0.05$ and $p < 0.0001$, respectively. Homaeinezhad et al. [12] have framed a supervised hybrid technique that includes the classifier with a QRS complex geometric extraction technique. A tough wavelet-based (WB) algorithm is used for detecting the ECG signal. Discrete Wavelet Transform (DWT) corresponding to each QRS region is divided into eight polar sectors and the length of the curve of each segment is calculated. The ability of the proposed classifier was determined to be 98.2% for 23 various rhythms and 98.06% accuracy for 7 number of arrhythmias of MITDB. Kutlu and Kuntalp [13] provided a comprehensive work based on the K-NN algorithm that includes higher-order statistics (HOS) for heartbeat recognition. The input to the classifier consists of the estimation of wavelet package coefficients and the determination of higher-order statistics. The arrhythmia database from MIT-BIH is used as an input dataset which is subdivided into five key groups. With the help of proposed work, the classification accuracy is measured by obtaining an average sensitivity, selectivity and specificity of 90%, 92% and 98% respectively.

Deboleena Sadhukhan and Madhuchhanda Mitra [14] suggested a simple and flexible algorithm to detect the R-peak. For locating the QRS areas, the square double difference signal of the ECG data is used. The proposed method includes the following: sorting and thresholding for locating approximate QRS regions, comparing the relative quantities of approximate R-peaks in QRS regions and processing of the RR interval to ensure the exact peak is detected. On 12-lead PTB Diagnostic ECG data, the algorithm is tested and 99.8% sensitivity is achieved. Deepu [15] has implemented a new technique for compressing the ECG data and QRS detection of in a wireless sensor device. The design is focussed on sharing the load between multiple tasks of signal processing and reducing the average complexity of each task. The compression ratio is achieved by an adaptive linear data prediction method based on the compression algorithm. Sensitivity of 99.64% and a positive output of 99.81% is achieved through this technique when tested using the MIT-BIH arrhythmia database. QRS detection algorithm and Empirical Mode Decomposition (EMD) based ECG signal enhancement technique was presented by Saurabh Pal and Madhuchhanda Mitra [16]. EMD is an adaptive technique for decomposing signals which produces IMFs as decomposing output. The suggested approach was checked with 21 randomly selected instances, most of which include normal, BBB, paced, PVC and fused beats. In total, 45,936 cases were validated, including 340,066 records and 11,870 records from another group. Sensitivity and precision were found to be 99.88% and 99.96% respectively. With the harmonizing features of Mixture of Experts (ME) and Negatively Related Learning (NCL), Javadia et al. [17] recommended an efficient classification system for arrhythmia detection and classification. The neural networks with negative correlation were trained simultaneously by using error functions. The NCL control parameter was incorporated into the ME error function to establish a balanced condition. The MIT-BIH arrhythmia database was selected for evaluating the framed technique and it produced 96.02% specificity, 98.01% accuracy and 96.72 % sensitivity. Islam and Alajlan [18] proposed a morphological synchronisation technique for the digital heartbeat signals of a human. The heartbeat is



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thus divided into stable and versatile parts that are sampled and concatenated at two different speeds. A re-sampling rate is determined based on the spatial error analysis carried out by the interpolation method. Amplitude normalisation suppresses the essential alteration of the re-sampled heartbeat. This piece-by-piece uniform re-sampling technique contrasts the re-sampled heart beat with uniform and re-sampling methods. Luz et al. [19] suggested the Optimum Path Forest (OPF) classifier, a supervised and efficient graph-based pattern recognition technique. This is a pattern classification scheme based on the optimum graph partitions in which each sample is defined as a complete graph node and the arcs are slanted by distance of their respective vector characteristics. OPF aims to track the competition process between some of the key samples. The robustness of the classifier is evaluated using MIT-BIH arrhythmia database. The accuracy and the sensitivity obtained using OPF classifier is 89.5% and 93.2% respectively. The application of higher order statistics for the classification of atrial arrhythmia was suggested by Martis et al. [20]. Non-linear dynamic models have improved the time series results and catch minute variations.

The cumulative and bispectrum coefficients are reduced for the selection of the best classifier with the use of Independent Component Analysis (ICA), Regression and Classification Tree (CART), Random Woodland (RF), Artificial Neural Network (ANN) and K-Nearest Neighbour Classifier (KNN). An average accuracy of 99.5%, sensitivity of 100%, specificity of 99.22% and positive prediction value of about 99.72% are obtained using ICA, which is better than HOS bispectrum approach. A novel ECG enhancement algorithm was developed and tested by Ning and Selesnick [21] based on spacious derivatives. Artifacts are decreased in the modelling of a clean ECG signal by solving a problem of convex optimisation and as a sum of two signals whose derivatives are sparse in second and third order. The most popular MIT-BIH arrhythmia database is used for the process of evaluation resulted in a sensitivity (Se) of 99.87 % and a positive prediction (+P) of 99.88 % prediction. Lim et al. [22] developed a simulation method in which U-ECG electrodes are placed optimally on 3D model surface. In order to obtain a potential map of the body surface and ECG waveforms relative to empirical effects, the cardiovascular model was simulated. The optimum position of the two 5 cm U-ECG electrodes for wave detection was determined using this model. Reyes et al. [23] developed hydrophobic electrodes that include dry and water-filled environments in morphological waveforms without ECG signal distortions. Various studies have been performed to test the efficacy of the CB / PDMS electrodes. The evaluation of electrode-to-skin contact impedance was used for various diameters, thicknesses and pressure thresholds. In the dry state, no statistical differences were found between the CB / PDMS and Ag / AgCl hydrogel ($p > 0.05$) electrodes for the temporal and spectral cardiac variability indices.

However, the quality of the signal decreased to the point that the morphological waveforms of the ECG were not discernible as water reached the Ag / AgCl electrodes. Zidelmal et al. [24] suggested an approach to detect QRS (ECG) based on the representation of S-Transform Time Frequency. Since S-Transform has reliable connection with the fourier spectrum, it serves frequency-dependent resolution. The advantages of the S-Transform are used in the time-frequency domain to detach the QRS complexes. The energy Shannon of each obtained local spectrum is determined to locate the R waves in the time domain. The performance of the proposed solution is validated with MIT-BIH arrhythmia database and it dispensed 99.84% sensitivity, 99.91% specificity and an error rate of 0.25%. Pornchai Phukpattaranont [25] suggested a quadratic filter-based QRS detection algorithm to increase the QRS S / N ratio. In ECG signal, QRS detection is a crucial step and a primary technique for obtaining various parameters. In order to test the efficacy of the proposed methodology, MIT-BIH rhythmic database is chosen and it provides an average error detection rate of 0.38% out of 48 records. Shaik et al. [26] proposed the Short Time Fourier Transform based adaptive spectrogram threshold technique for detecting complex Electrocardiogram (ECG) QRS signal. The algorithm involves in pre-processing the raw signals, measuring STFT, application of adaptive thresholding technique and QRS peak identification. The proposed system on evaluation against MIT-BIH arrhythmia database, the sensitivity, specificity and error detection rate are found to be 99.56%, 99.52% and 0.93% respectively. A wearable ECG was developed by Wang et al. [27] using Human Body Communication (HBC) pulse radio (IR) technology in order to transmit critical signals in a wearable scenario to the human body. The HBC based wearable ECG has two unique features. Initially, very low radiation power is fed to the transceiver to satisfy radio rules that are incredibly weak and do not require a licence. This function will make the wearable ECG very convenient. Then, it is simplified by the sensing and transmission of electrodes based on time sharing and power coupling. Validity and efficacy were





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measured on the basis of the findings obtained and it is found that the device in place is best suited to healthcare. The Reverser Biorthogonal Mother Wavelet Transform based QRS complexity detection technique is modelled by Kholkhali and Reguig [28]. The coefficients obtained through this technique are filtered using non-linear and median filters. Once filtered, they are transferred to the dynamic threshold for QRS detection. The suggested technique yields 99.73% Sensitivity, 99.9% positive predictive value and 0.37% error detection rate. Cuomo et al. [29] focused on recursive filtering and presented a revised method of denoising signal. A suitable class of kernel functions is suggested, beginning with noise frequencies inside the Fourier domain, to eliminate artefacts in the ECG signal. High performance computing are not required and hence the execution is performed directly on mobile devices. Experiments in terms of estimation and precision have been performed on actual datasets for research. The results show that the time consumption of RF and BPF is lowest and the memory is smallest.

The Discrete Wavelet Transform (DWT) method is used by Sahoo et al. [30] for the elimination of the noisy components for the ECG signal enhancement and the adaptive thresholding technique with Hilbert transform which is used to explore the optimal combination. MIT-BIH database is chosen for testing the proposed technique. The overall S/N ratio is found to be higher with a low mean square error compared to other techniques. The technique offers 99.71% of sensitivity, 99.72% of positive predictability and a lower error detection rate of 0.52%. Ingale et al. [31] contributed off-the-shelf ECG dataset that leads the research community to explore new opportunities. The authors examined the effect of filtering, segmentation, extraction of features, and ECG biometric health status using assessment metrics. The results obtained shows that the biometric authentication outperforms current techniques. This is evident, considering the noisy, unsafe ECG signals, by achieving 100% accuracy on evaluating various datasets and an average Equal Error Rate (EER) of 2.11 % is obtained from 1,694 subjects. Guangyu Xu [32] suggested the IoT Assisted Electrocardiogram (ECG) Monitoring Method for Continuous Cardiovascular Health Monitoring. For the purpose of data transmission with security, Lightweight Secure IoT (LS-IoT) along with Lightweight Access Control (LAC) were proposed. A sensitivity of 96.5% is achieved for noisy and 98.4% for noise-free categories. Miao et al. [33] introduced a method of fiducial and non-fiducial extraction of mixed features that leads to multidimensional modelling. A linear discriminatory analysis (LDA) based on a multifunctional (LOMF) algorithm is also suggested to solve the time-over-time problem of large-scale data training. The results of the experiment show that the use of the ECG mixed function returns a higher recognition rate in a number of scenarios. The accuracy obtained through LOMF is 97% and the computational time is 10.862s.

Analysis of ECG Arrhythmia Classifiers

The Classification of ECG signals for Arrhythmia detection based on Accuracy for different methods as been listed below. Choi et al. [34] develops a driver ECG measurement framework that tackles lack of adaptability, unreliable ECG signal and the potential of creating irritation to the driver. A conductive fabric-shaping technique was used to increase the flexibility, cost reduction and complexity of the required signal-conditioning circuit. The findings obtained with this method are compared to the ECG measurement results from a clinical ECG monitoring system. The proposed system offers a high degree of SNR value of 15.11 whereas in the contact and non-contact measurement system the SNR value is only 8.7. A Coherent system for auto-detect, localization and classification were developed by Satija et al. [35]. The proposed system consists of the Updated Ensemble of Empirical Mode Decomposition (CEEMD), the extraction of short-term temporal features and the rule-based detection and classification system. An algorithm based on decision to detect noise and classify processed ECG signals is developed and implemented. Considering noise, the system achieves a mean sensitivity of 99.12%, 98.56% specificity and 98.90% accuracy. The classification resulted from a learning method, can be either abnormal case or normal, named as positive class or negative class, respectively. Result of the prediction can also be either true or false, implying on correct prediction or incorrect prediction, respectively. Thus, We can summarize classification into four possible states:

1. True positive (TP): Correct prediction of positive class
2. True negative (TN): Correct prediction of negative class
3. False positive (FP): Incorrect prediction of positive class





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4. False negative (FN): Incorrect prediction of negative class

Based on the classifications predictions, the Accuracy, Specificity, Sensitivity and Precision are calculated as follows

$$\text{Accuracy} = (\text{TP} + \text{TN}) / (\text{TP} + \text{TN} + \text{FP} + \text{FN})$$

$$\text{Specificity} = \text{TN} / (\text{TN} + \text{FP})$$

$$\text{Sensitivity} = \text{TP} / (\text{TP} + \text{FN})$$

$$\text{Precision} = \text{TP} / (\text{TP} + \text{FP})$$

Antoni Burguera [36] proposed a quicker method focused on a basic study of the temporal structure of the ECG to detect QRS complexes. Several steps such as removal of noise, feature recognition and analysis are involved in processing the ECG signal. The dataset after processing will be a compressed version and also occupies low data storage. Using the proposed method, 130 minutes of ECG recordings are processed in 0.77 seconds. Also 99.9% and 90.35% of sensitivity and positive prediction was achieved. Liu et al. [37] designed and developed an IoT-based SmartVest Early Cardiovascular Disease (CVD) detection system consisting of 12-lead ECG with four major components. The authors focussed on dealing with the Signal Quality Assessment (SQA) and lightweight QRS detection. A single-channel ECG signal grading is performed by means of a lightweight QRS detector in order to determine the position of the complex QRS signals. By providing outstanding F1-score of 99.5% and other dependent parameters, the proposed SQA methodology demonstrates its efficiency. Majumder et al. [38] have developed a wireless ECG monitoring device for long term cardiovascular health surveillance using versatile and dry capacitive electrodes. The ECG signals are measured by using a thin material placed between the skin and the electrodes. A data acquisition system is modelled for the collection of ECG signals from the electrodes. A software application for encoding, storing and displaying the ECG signal was built. The experimental results suggest that our ECG system efficiency is comparable to the other released ECG monitoring systems. The Cardiac Conduction Device dependent heterogeneous oscillator model was developed by Quiroz-Juarez et al. [39]. The developed model consists of natural pacemakers represented by M-Van Der Pol equations. An artificial RR tachogram is used, which provides information on the heart rate and the features of its frequency domain. The developed model has the ability to simulate realistic ECG signals, including pathological phenomena. This model has major advantages over current nonlinear cardiac models.

Artificial Neural Networks

As a key biometric instrument for human identification, ECG is used by Abdeldayem and Bourlai [40]. The architecture includes the segmentation of the ECG signal and its cyclostationarity and spectral correlation, which are used for enriching the original signal content and establishing spectral correlation images. Our spectral similarity image is fed into the CNN Architecture in two neural networks that is tested and evaluated before recommending a final architecture. The evaluation is carried out on nine small and large ECG databases. It is inferred from the results that, irrespective of database, the method contributes to improved device efficiency resulting in 95%, 0.2% and 0.1% precision, false acceptance and misrepresentation. In order to track fECG R waves from abdominal ECGs (aECGs), Liu et al. [41] merged RR time series smoothing and template matching (TM) method. The misaligned cases are analyzed and skipped R wave detection in the RR time series based on the quasi-periodicity of the R wave and developed a modification algorithm to classify and correct them. To detect the fECG R wave overlapping with mQRS in the estimated area, a TM algorithm has been developed. The efficacy of the proposed solution was assessed using the F1 measurements and the Bland-Altman study. High precision values corresponding to 95% and -0.04(±)9.00 ms were obtained, respectively. A Personal Identification System using self-ECG time-frequency representation signal-based electrocardiogram (ECG) network was developed by Lee and Kwak [42]. The authors used wavelet analysis and Regional principal component analysis network (RPCANet) for this purpose. The developed method has been checked on a publicly shared data set obtained from the Chosun University ECG Database (CU-ECG DB). The proposed system generates 98.25% accuracy and 97.5% recognition rate. Yang & Wei [43] suggested an effective method in combination with a novel morphological feature for the correct identification and arrhythmias classification. The actions of the ECG signals are detected and the parametric characteristics are then extracted from the selected ECG signals. A new function is proposed to test QRS dynamic morphology shifts as visual patterns and a new algorithm to extract clustering-based properties. Finally, for automatic diagnosis Neural Network, SVM, and



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KNN classifiers are applied to the feature vectors. The proposed procedure was tested with 15 types of heartbeat randomly selected from MIT-BIH arrhythmia database and an overall accuracy of 97.70% was achieved. ECG signal reconstruction mechanism using Doppler sensor was designed by Yamamoto et al. [44] using a deep learning model that comprises Convolution Neural Network (CNN) and the Long Short-Term Memory (LSTM). The ECG signal is reconstructed on the basis of the extracted characteristics. In order to observe heartbeat, experiments are conducted against 9 stable subjects without heart failure. A correlation coefficient of 0.86 was obtained with the help of the proposed model. Cherupally et al. [45] have established a precise low-power device authentication method using ECG signals as biometric modes. The proposed ECG processor consists of the front-end signals processing and the efficient authentication of back-end neural networks. To train NNs, a cost function that minimises intra-individual distance over time and maximises inter-individual distance is used. By applying the fixed coefficients for pre-processing of the ECG signal, hybrid low-precision and standardised NN sparsity optimization, effective low-power hardware was introduced. For pattern recognition in embedded biomedical applications, algorithms such as Fast Fourier Transformation (FFT) are important and have been the subject of further research. FFT-based signal processing is usually measured to provide low-power operation on deeply integrated devices, such as cardiac pacemakers, via an Application Specific Integrated Circuit (ASIC). Vanitha et al. [46] suggested a suitable design to increase the battery life for cardiac pacemakers. The software base relies more on the latest pacemaker technologies and a latest approach is needed as hardware restrictions become less restrictive. To allow the management of more complex data with much larger collections, a more general approach to data management needs to be addressed. Remote control with telemetry was also observed and analysed.

Deep Learning Techniques

Deep Neural Network (DNN) has been generally utilized for characterization and expectation purposes in various areas. As of late, it has been seen that DNNs are being grown pointedly with a massive impact on the exactness in grouping for many clinical undertakings. Current CADs frameworks influence DNNs to recognize arrhythmia of caught ECG signal prompting decline the expense of constant heart checking and working on the nature of forecasts. Notwithstanding, an ECG-based programmed arrhythmia grouping is regularly confronted with a few significant difficulties. In the new years, a few Deep Learning (DL) models have been proposed to work on the precision of various learning methods, including Convolutional Neural Network (CNN), Recurrent Neural Network (RNN) and Long Short-Term Memory (LSTM). Time-developing brain network is an elaboration of time-deferred brain organization, as of late acquainted with the setting of learning hypothesis. CNN is one of the most famous DNN design typically prepared by a slope based streamlining calculation. A CNN comprises of different consecutive layers associated in a feed-forward way. The fundamental layers are including convolutional layer, standardization layer, pooling layer, and completely associated layer. Three first layers are answerable for extricating highlights, while completely associated layers are responsible for characterization. RNN is an augmentation of an Artificial Neural Network (ANN) whose loads are shared across time. RNN is the most legitimate learning model for learning successive information and the time-series information order where the criticism and the current worth is taken care of again into the organization and the result contains the adding of values in the memory. At each time step, the RNN gets an info, refreshes its secret state, and makes a forecast. RNN involves inclination plunge calculation through time for preparing the loads. RNNs has profoundly unique way of behaving because of nonlinear enactment capabilities utilized by the secret units. LSTM is a particular sort of customary RNN intended for worldly groupings and the long-range conditions. LSTM utilizes memory blocks rather than basic RNN units where every memory block incorporates at least one memory cells with a couple of versatile multiplicative entryways as the info and result. A memory block places data and updates them across time-steps in view of the info and result entryways. The entryways control the info and result stream of data to a memory cell.

CONCLUSION

Most researchers in the literature have developed a system based on various techniques and algorithms. Each methodology presented in the literature has its advantages and disadvantages. The performance of the detection





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system developed is very promising, but further assessment is required. For the diagnosis of heart disease, automatic detection of ECG waves is important. Successful ECG analysis system output largely depends on the exact and accurate identification of the QRS complex, waves T and P, and most researchers rely exclusively on those diseases. The findings reported in the literature typically use the highly unbalanced MIT-BIH database. However, writers who use the intra-patient scheme have overlooked this aspect. Authors taking a more practical approach and opting not to combine heartbeats with training and testing (inner-patient system) reported great difficulties in achieving promising results for the SVEB and VEB heartbeat arrhythmia courses. As such, various suggested approaches do not adopt a fairer assessment procedure in the literature. In order to produce best results, many researchers use semi-automatic approaches [48]. The results of the semi-automatic approaches could rise up to 40%, even if small number of heartbeats are selected for adaptation. The downside, however, is the expert intervention. But intervention is a common scenario in the clinical environment and so this is a promising research direction. In view of fully automatic method, the protocol suggested by de Chazal et al. [49] was indicated as most fair presented in the literature due to the use of imbalanced records in the dataset. Machine learning group researchers demonstrated that the size / diversity of databases used for system building affect more than choosing the learning algorithm and/or techniques used[50]. In a variety of research fields involving pattern recognition, attempts were made to establish or even increase the size of existing databases and to establish uniform evaluation protocols to prevent arbitrary comparisons between different approaches. Completely automatic heartbeat (arrhythmias) classification in ECG with reduced data bases is one of the main obstacles to advancing in science. The research group is therefore encouraged to explore the problem of the heartbeat classification to encourage / simulate the expansion of the database dedicated to this purpose. New patterns are also proposed to clasp the ECG signal for the creation of new databases, such as off-the-person approaches. It is nevertheless assumed that the development of such databases would be an essential task because they would have to be integrated into standards such as AAMI standards to meet the target audience, in addition to the financial costs involved.

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Table 1 Performance measurements of different ECG arrhythmia classifiers

Work Reference	Methodology	Accuracy
Homaiezhad et al.[12]	Discrete wavelet transform	98.06%
Javadia et al.[17]	Negatively related learning	98.01%
Luz et al.[19]	Optimized path Forest classifier	89.5%
Martis et al.[20]	Independent component analysis	99.5%
Miao et al.[33]	LOMF Algorithm	97%
Satija et al.[35]	CEEMD Algorithm	98.9%
Lee and Kwak [42]	RPCA Net	98.25%
Yang and Wei [43]	QRS Dynamic morphology	97.7%

Table 2 Performance comparison of different ECG arrhythmia classifiers

Work Reference	Sensitivity	Specificity	Methodology
Kutlu and Kuntalp [13]	90%	98%	K-NN Algorithm
Deepu [15]	99.64%	99.81%	Adaptive linear prediction method
Saurabh Pal and Madhuchchanda Mitra [16]	99.88%	99.96%	Empirical Mode Decomposition
Javadia et al.[17]	96.72%	96.02%	Negatively related learning
Martis et al.[20]	100%	99.22%	ANN and K-NN Classifier
Zidelmal et al.[24]	99.84%	99.91%	S-Transform Time frequency
Shaik et al.[26]	99.56%	99.52%	Short time Fourier transform
Kholkhali and Reguig [28]	99.73%	99.9%	Reverser Bio-orthogonal Mother wavelet transform
Sahoo et al.[30]	99.71%	99.72%	Discrete Wavelet transform
Satija et al.[35]	99.12%	98.56%	CEEMD Algorithm
Antoni Burguera [36]	99.9%	90.35%	QRS Detection



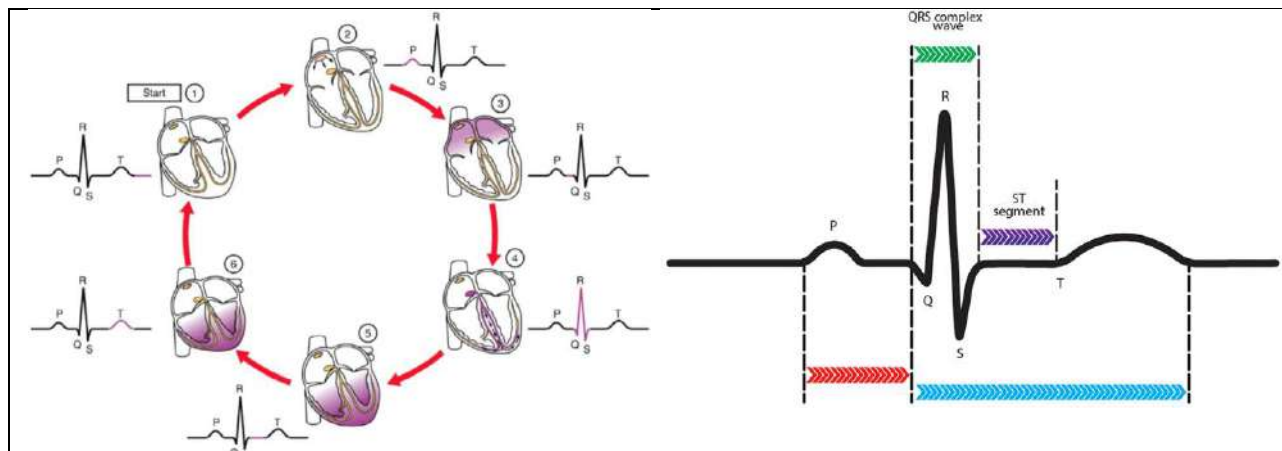


Figure 1 Cardiac cycle and related waves of an ECG signal

Figure 2 Normal ECG signal



Figure 3 Architecture for ECG signal classification

Figure 4 Performance measurement of ECG Arrhythmia classifiers

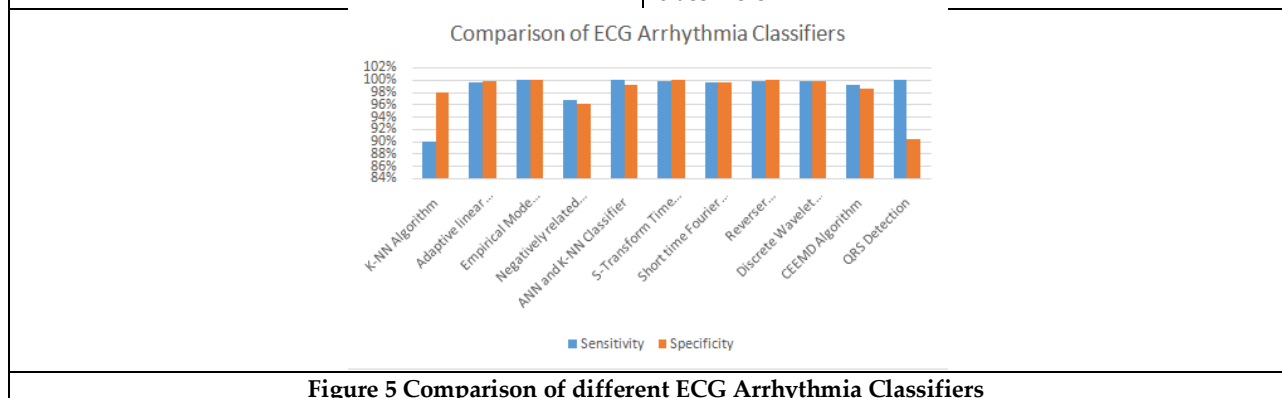


Figure 5 Comparison of different ECG Arrhythmia Classifiers





Literature Review of *Aruvaimaruthuva karuvigal* (Surgical instruments) in Siddha System of Medicine

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ABSTRACT

Siddha medicine is a holistic medical system that deals with internal medicine, external medicine, and surgical administration. The surgical procedures are carried out with surgical instruments and medical appliances. The *Siddha* system of medicine includes different types of instruments which are used in surgical and para-surgical procedures. Stone inscriptions excavated by archaeologists in Tamil Nadu, *Thirumukkoodal* reveals the surgical procedures in the *Siddha* system of medicine was practiced during that period. Many Tamil literary works like *Purananuru*, *Kampa Ramayanam*, *Ettuthogai*, *Nalayuradivya prabantham* describe the surgical management of olden times. The literary review on *Siddha* surgical instruments is aimed at collections of shapes, size, types, measurements and uses mentioned in various *Siddha* literature. Literature about *Siddha* surgical instruments were reviewed from Library of National Institute of Siddha, Govt. Siddha medical colleges, Siddha practitioners, e - books and Research articles. 30 books were identified and collected for this review study. 30 surgical instruments are mentioned in *Agathiyarnayanavithi* 500, 26 instruments are mentioned in *Agathiyar* 2000, 28 surgical instruments are mentioned in *Rajasekaram*, 2 instruments are mentioned in *Nagamuninaya navithi*, 8 instruments are mentioned in *Nagamunithalai noi maruthuvam* and *Pararasasegaram*, 29 instruments mentioned in *Agathiyarviranakarappanrogasigichai*, 23 instruments are mentioned in *Sambasivampillai* medical dictionary. In the *Siddha* system, the documentation of surgical instruments is very limited.





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Nowadays the practical application of surgical instruments is less due to a lack of literature evidence. So, I conclude this study reveals information about the *siddha* surgical instruments which may be useful for various clinical studies and academic purposes.

Keywords: Instruments, Literature, Siddha, Surgery

INTRODUCTION

Siddha medicine is a holistic medical system deals with internal medicine, external medicine and surgical administration. In *Siddha* system of medicine, the treatment has been classified into three major groups. These are *Vinnavarumaruthuvam*, *Maanidar Maruthuvam* and *Asura Maruthuvam*. *Asura Maruthuvam* is one of the surgical administrations in the *siddha* system of medicine. It includes three main categories like *Aruvai Parikaram*, *Akkini Parikaram* and *Kaara Parikaram* which are surgical and para surgical procedures. *Aruvai parikaram* is 13 types, *Akkini parikaram* is 5 types and *Kara parikaram* is 7 types. Surgical and para surgical procedures are conducted by the aid of *siddha* surgical instruments in ancient days. Many ancient Tamil literary treatises like *Pathitru Pathu*, *Tholkaapiyam*, *Kambaramayanam*, *Nalayuradivayaprabantham*, *Sevagasinthamani* and *Kurinjipaattu* describe the surgical management of olden times. [1] Suturing techniques are mentioned in *Pathitru Pathu*, [2] amputation technique is mentioned in *Tholkaapiyam*, [3] cauterization technique is mentioned in *Nalayuradivayaprabantham* [4] and *Kambaramayanam*. [5] One of the Indian two mythical history of epic is *Kamba Ramayana*, which is mentioned that,

“Udalidaithonditruondraiaruthathanuthiraothri

Sudalurasuttuvaerormarunthinaarrayaramtheervar”

The above verse reveals the importance of surgery in ancient days, that in human body any abnormal growth was removed by surgical procedure, drainage of blood followed by cauterization. Finally, treated with internal medications. [5] Intracranial surgery was performed by saint *Agasthiyar* and *Theraiyar* in ancient days (BC 3000). [6,7] Surgery is not advisable during the lunar phase of zodiac sign and birth star. Surgery is performed by following days like Tuesday, Saturday, the period when Mars is strongest in the cosmos, at a time when there are no planets in the 8th to *lagnam*, *mesham*, *kadagam*, *kanni*, *rishabamlagnam*, 4th *Thithi*, 14th *Thithi* and 9th *Thithi* days, *kettai*, *Thiruvathirai*, *Moolam*, *Ayulyam natchaththira* days. [7] The granite sculptures found in *Thirumukkoodal* mentions about the trained person doing surgery using sharp instruments as *sathriyan* (a precursor term used for surgeon). A medical man who used to operate wounds, sores, carbuncles, abscesses etc with instruments and then treated them by medical appliances employed either externally or internally known as *sathriyavaithiyan*. [8] In *Siddha* system of medicine, the documentation and usage of surgical instruments is very limited. Nowadays the practical application of surgical instruments is less due to lack of literature evidences. So this study was conducted to Collect and Document the information of *Aruvai Maruthuva Karuvigal* and its procedures mentioned in various *siddha* literatures.

METHODOLOGY

Study place: National Institute of Siddha

Study type: Literature review

Study period: 6 months. Collection of information about *Aruvai Maruthuva Karuvigal* and its Procedures mentioned in various *siddha* literatures and data was analysed.

Ethical considerations:

Before the commencement of the trial, the study protocol was submitted to the institutional ethical committee (IEC number; NIS/IEC/2020/MP-21 Dated: 09-05-2020) of NIS, Chennai and approved.





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MATERIALS AND METHODS

Kaththi

Kaththi is a surgical knife, 6 inches long and 1-inch breadth. The terminal circle is like a hair knife. [9] Wide is 3 fingers; length is 3 1/2 inches and end are semi-circular in shape. [10,11] A cutting instrument of various shapes and sizes used for operating the several diseased parts of the eye. The different kinds are: [8]

- *Kankaasakaththi* – A knife used in operations for cataract.
- *Vizhikunthakaththi* – A knife used for excising staphyloma of the cornea.
- *Sirungaikaththi* – A knife used for cutting the cornea in operations for cataract.
- *Theeikkumkaththi* – A knife used for cauterising the eye to arrest bleeding.
- *Suzharkaththi* – A knife used in a circular extraction of cataract.

Sathiram

Sathiram is surgical knife resembling to neem leaf like structure. It is used to cut the muscle fibers, abscess and carbuncles. It is 6 inches long and weighs 6 *kazhanju* (30.6g). [9,10,11]

Kurumbivaangi

Kurumbivaangi is 7 inches long and weighs 1/2 *kazhanju* (2.55g). The handle is 5 inches long. [9] It is used to remove the wax, insect and beetle from the ear. [7,16] It is 7 inches long and 1 1/4 *varagan* (7.35g) weight. One end has a smooth small groove like a spoon to collect the ear wax. It may be fixed with a handle about 5 inches made from wood. [10,11,12]

Mugavathanan

Mugavathanan is 12 inches long and weighs 3/4 *kazhanju* (3.83g). [9] It is 12 inches long, weighs 3 3/4 *varagan* and it has three probes each 3/4 *kazhanju* (3.83g) weight. [10,11,12]

Mulvaangi

Mulvaangi is 6 inches long, 1-inch breadth and weighs 1 *kazhanju* (4.1-gram). It is used for dissection and incision. [9] It has a sharp flattened metal which is fixed between the two ends and weighing about 1 1/4 *varagan* (4.83 grams). It helps to cut and incise the masses. It may also be used to cut the nails. [10,11,12]

Azhikol

Azhikol is half ring shape instrument used for removing circular tissues. [8] It is 10 inches long and weighs 1/2 *palam* (17.50g). [9,11,10] Among 10 inches length, the anterior 5 inches is made up of circle in shape and posterior 5 inches is made up of a handle. [8,10]

Piraikol

Piraikol is 3 inches long and 3 *kazhanju* (15.30g) weight. [9] It is 9 inches long and weighs 3 3/4 *varagan*. One end of the *piraikol* has sharp tip about 3 inches long and another end has half-moon shaped tip. [11,12]

Katharikol

Katharikol is 8 1/2 inches long and weighs 1/4 *palam* (17.50g). [9,10,11] It is simple and sharp scissor used for cut the muscular fibers, ligaments, hairs etc. [7,16]

Parakaraivaangi

Parakaraivaangi is a hook like instrument used to pull the retained or unwanted tissues. [8] It is 16 inches long and weighs 1/2 *palam* (17.50g). One end of the *parakaraivaangi* has a groove about toor dal (*Thuvaramparuppu*) size. It is used to treat dental diseases, tooth stain and other diseases like vitiligo. [10,11]





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Muchilagai

Muchilagai is an instrument with three ends joins to form a triangle. It is 7 inches long and weighs 4 *kazhanju* (20.40g).[9] It is otherwise called as *Mookusalagai*. It weighs 5 *varagan*(21 grams).[11,12]

Munimozhi

It is an important tool.[9]*Munimozhi* is a blunt instrument like a bent probe to make insertion into the openings. It is otherwise called as *Mozhi pottu*.[10,11]

Ottukol

Ottukol is 11 inches long and weighs $\frac{1}{2}$ *palam*. The head part of the instrument weighs 1*kazhanju* (4.1g).[9]*Ottukol* is an instrument with large head used to dilate the openings. [12]

Attakkol

Attakkol is a long probe used to insert in the large openings.[12]It is 18 inches long and weighs 8 *kaasedi*(6.40g).[9]It is 18 inches long and weighs 8 *varagan*(33.60g) and thick as *Tamarindus* leaf.[11]

Oosi

It is 3 inches long and *Arimaa*(1.04g) weight.[9]It is a strong, durable needles used for stitching the cut ends of the skin. It consists of 3 kinds used according to circumstances. According to the text *pararasasegaram*, the tube-like needles are inserted into the abdomen to absorb the water. Needles were used for *suttigai* therapy. A needle with a handle is used to pierce the ear and nose.[7]*Madaloosi* is a needle used for removing cataract.The several other varieties are, [8]

- *Kannusi* (Cataract needle)– A needle for use in removing a cataract
- *Kuzhalusi* (Ligature needle) – A needle used for tying up blood vessels or bleeding artery
- *Purai oosi* (Probe) – A kind of blunt needle used for intruding into wounds or sinuses for exploring them.

Seppukuzhal

It is a tube-like structure used to insert the wounds. It is 12 inches long and weighs $\frac{1}{2}$ *palam* (17.50g). The thickness is equal to a palm leaf. (*Sepputhagattuolaikanam*). [9] It is a probe made up of copper with a tube or opening inside. It is also used to inject oils or medicine into the opening. [11,12] A probe made of copper and used for applying the eye with collyrium.[8]

Salagai

Salagai is a probe for exploring a wound.It is 4-5 inches long and weighs 12 *kazhanju* (61.20g).[9]According to another text *Virana karappanrogasigichai*,[11]

- *Iruppusalagai* is 1 *chaan* (12 *viralkadai*) length and weighs 20 *kundri* (2.60 grams). It is used to probe and cut the wound opening.
- *Salagai* is 9 inches long, weighs 60 *kundri* (7.80 grams) and used to perform the cauterization.
- *Thaligaisalagai* is 4 or 5 inches long, the end is blended and paddy like thickness. It is used to measure the depth of the abscess.

Vattagai

Vatagai is an instrument like as probe. [9,10]

Panjamugam

Panjamugam is an instrument. It is 11 inches long and weighs $7\frac{1}{2}$ *varagan*(31.50grams). It is usually placed on the skin and gently rotated with mild pressure on the affected area of the skin which has swelling and pain (*soolai*).[11,12]





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Seppusilagai

Seppusilagai is 12 inches long and 20 *kundri* (2.6 grams). It is made up of copper. It is used to measure the depth of the wound and insert the medicine into the head through *salagai* instruments in the conditions of delirium and snake bite.[10,11]

Kombu

Kombu is a suction instrument made up of brass. It is 10 inches long and the base of the horn surrounded by brass. It is 2 inches diameter. It is used to suck blood or fluid from a hematoma or abscess after making an incision. [9,11,12] The sharp ended horns are used to suck blood, spoiled breast milk. The base of the horns is three inches wide and tightly tied with leather to look like a bag. [7]

Kudori

A small axe like instrument, oblong in shape like the teeth of a cow, with a sharp edge about half inch in length. The *kodari* instrument used when the treatment of *kudori* therapy. It is fixed to a rod and is used for cut the veins over the surface of bones to trace out the foreign matter. [7] It is 7.5 inches long and weighs $\frac{1}{4}$ *palam* (8.75g).[9,11] *Kudori* is an instrument which looks like an axe, used to treat *sukkiran*, an eye disease caused by vitiation of *vatham*. It causes severe eye pain. The appropriate place exactly two fingers above the forehead should be pressed to locate the venous prominence. *Kudori* therapy should be done accurately on that place. [9,12] According to *Samba sivampillai* medical dictionary, the making of small incisions or punctures in any part of the body for the purpose of abstracting blood or any fluid in certain diseases. [8]

Vengalakuzhal

Vengalakuzhal is 8 inches long and weighs 3 $\frac{1}{2}$ *palam* (122.50g). It is used for fumigation therapy by inserting the brass flatus tube into the anal canal. So, it is also called as *Abana kuzhal* or brass flatus tube. [9,11,12]

Eyasalagai

Eya salaagai is 3 inches long and 4 *kazhanju* (20.4g) weight. [9] It is 3 inches long and weighs 5 *varagan* (21 grams). It is used to treat the carbuncles and infected wounds. [11]

Kaayakol

Kaayakol is 7 inches long, weighs 2 *kazhanju* (10.20g) and 2 inches diameter.[9] It is 7 inches long and weighs $\frac{1}{8}$ *palam* (4.375 grams).[11]

Thandusalagai

Thandusalagai is 9 inches long and weighs $\frac{1}{2}$ *kazhanju* (2.55g). The thickness of the probe is similar to rib of the coconut leaf (*Eerkukanam*). It is used to cauterize the wounds. It weighs 20 *kundri* (2.60g). [9,11]

Nayanakaththi

Nayana kaththi is 3 inches long and weighs 2 *panavedai* (976 milligram). One end is sharp and the entire instrument is encircled by a thread, leaving the leaf of *Tamarindus indicus* space thickness (About 0.1mm) in the sharp end. [9] It is 3 inches long and weighs 3 $\frac{1}{8}$ *kundri* (406.25 milligram) encircled by a thread, leaving a paddy tip space in the sharp end. [11,12]

Anjanakol

The length of *anjanakol* is not more than five finger breadths. It is swollen in the middle part and the both ends are like a flower bud and the tip is sharp. *Anjanakkoel* should be made from copper, gold or silver. A rod used to blacken the eye lashes. [9,12]





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Kaariyakol

Kaariyakol (lead stick) is used to apply the collyrium for various eye diseases. [9,12,13]

Araiseelai

Araiseelai is an ophthalmic surgical instrument. If the pain in eyes and then radiate to the head, noted the prominent vein in the forehead is carried out by using *araiseelai* instrument. [10,12]

Vilisam

Vilisam (*Pilisam*) is a small ophthalmic surgical instrument whose tip looks like seeds of *karunjeeragam* (*Nigella sativa*). *Naga padalam* starts from lateral corner of the eye, crossing white part of the eye, reaches the black part and touches the pupil. This can be removed by the *vilisam* instrument. [1,9,13]

Kaakaikaal

A surgical instrument looks like crow's leg. The instrument is made red hot and pressed on the centre of the prominent nerve sheath in the eye and temporal area. It could be used to treat the conditions of *vizhiunthal* (Diseases in the black of the eye). [1,14,17]

Pulladi

Pul means a bird, *Adi* means foot. *Pulladi* is an instrument looks like bird's foot. The sharp tip of the instrument is heated and pressed deep above the eyebrow and ear nerves. The wound would be healed after seven days. It could be used to treat the conditions of *kanezhuchi* (Morbid growth of the eye) and ear abscess. [1,14,17]

Puththumanpaththu

Puththuman is mixed with magnetic ore and heated in a chamber. It is made as a roll, two finger breadth and used for cauterization. [11]

Mandalakiram

Mandalakkiram instrument is prepared from glass or brass, having a curvature at the cauterizing end. The eye lashes are pressed well and reverted to see the inner part. If we find a reddish flesh growth, the disease is *parparogam*. It could be treated by cauterization using *mandalakkiram* instrument. [9,12,16]

Roma moola karuvi

Roma moola karuvi is a semi-circular thin hair breadth surgical blade used to remove bent hairs (*Mudamayur*). The lash is lifted outwards and upwards and the hair is removed from the root. The lash is returned to its previous place without bending inwards. [12,14,17]

Thelliyakaruvi

Thelliyakaruvi is a minute ophthalmic surgical instrument whose tip looks like *ellu* seed (*Sesamum indicum*) shape. It is used to pull and replace the overgrown flesh in the eye. After replacing it, *thirikadugupodi* is sprinkled and rubbed softly. Any eye drop should be applied only after three days. [12]

Neekkiazhithidumkaruvi

The *kazhalai* (Tumour) growth in the eye is removed at the prominent tip of the growth, using a surgical instrument called *neekkiazhithidumkaruvi*. [9,12]

Seruthidumani

The *seruthidumani* is an ophthalmic instrument used to collect and drain the blood in *uthirakuntham* and the flesh is completely peeled out in *sathaikuntham*. [12]



**Ponmozhi et al.,****Madangal**

Madangal is an instrument used to do *suttigaithery* (Cauterization) to cure *padalam* (Cataract). It is used to cut, peel and give hot metal cauterization. It is also called as *avayarukaruvi*. [1,9,12,17]

Soolam

Soolam is a surgical instrument for performing cauterization in *kabala paarisavatham* which may be compared with bell's palsy and migraine. *Soolamkaruvi* is one among 98 *ratchai* instrument, it could be used to make an incision or cauterization. A *ratchai* therapy should be made in the nape of the neck and the center of the affected eyebrow to treat *kabala paarisavatham*. [14,17]

Pottusoottukol

In *siddha* medicine, cauterization is known as *Irattchaivanguthal*. Mole of the tongue can be treated by *iratchi* (cauterization) through these two cautery instruments. Initially the mole is roasted mildly by *pottusoottukaruvi* and then the area around the mole is cauterized using *Azhisoottukaruvi*. A 4-5cm hot metal cauterization is done on the dorsal side of the left-hand wrist to cure viral hepatitis. *Pottusoottukol* looks like a circular coin with a handle. It is used to cauterize the malignant growth and arrest bleeding. [12,14,17]

Azhisoottukol

Azhisoottukol looks like a ring along with a handle. It is used to cauterize the malignant growth and arrest bleeding. [1,17] It is heated to red hot and put on the enlarged tonsils and abnormal growth in tongue. [14]

Kaivaal

It is a small hand – saw about 10 inches long and 2 inches breadth with sharp ends and a strong handle. It is used for cut the bones. It is also called as *karapathiram*. [7,16]

Vindakanni

It is a tube-like structure; the holes are present sides of the tube. It is used to examine the diseases of throat, vagina and anus. It is 5 inches length, 5 inches circumference. [7,16]

Saarimugam

It is a long knife with a sharp end like a bird's beak, used for promoting bleeding or haemorrhage. [7,16]

Thuvamugam

It is two faced probes flattened at the ends of two copper rods and fixed with a knob which similar to the bud of henna flower. It is used in case of amaurosis or total blindness in which the lens is affected. [7]

Virigi

It is a sharp knife like the paddy end and flattened to a length of 1 1/2 inches (2.5 gram), used for open the blood vessels and abscess. [7,16]

Siruvaaal

It is a knife resembling a small saw bent at the end, used to treat the eye diseases like *parparogam* and to cut the muscle flesh. It is also called as *Mandalakiram*. [7,16]

Uthpalapathiram

It is a lancet of a short length with a blade like the petal of a water lily, used ordinarily for cut the wounds. [7,16]

Viruthi

It is a wide chisel like instrument, used to make tear, incision and cut. [7,16]



**Ponmozhi et al.,****Muthari**

It is an instrument three blended ends, used for the management of kidney diseases like *kalladaippu* and *sathaiyadaippu*. [7,16]

Sirusathagam

It is a flattened instrument; one end is long and same side another end is small. It is used to remove the nail, thorn, tip of sticks, dirt and cut the muscular fibers. It is also used for cut, stab and scratch. It is also called as *kabathiram*. [7,16]

Paambusathagam

It is a surgical knife with an end resembling the face of a snake and flattened sharp instrument, the length is half inch. It is inserted into the nose or ears for removing the polyps. [7,16]

Thoondil

It is a sharp instrument, curved end used to pull the artery, nerves and palate etc. It expels the fish thorns and hairs stuck in the throat. [7]

Angusam

It is sharp needle with centre part is curved. It is used to promote the unconscious state. [7]

Thathari

It is an instrument used to detect and repair irregular tooth and to remove the tooth stain. [7]

Thirikoorsaram

It is a needle with three flattened ends, used for promote bleeding in diseases of skin like *kuttam*, *venpulli* (Vitiligo), dry thickened skin diseases. [7]

Sathagam

It is a sharp instrument, flat and thin plate. It is important in surgical operations. The different types of knives are based on shapes. These are *Agala sathagam*, *Valaivusathagam*, *Siru sathagam*, *Uthpalasathagam*, *Vanjiilaisathagam* (*Vethasapathiram*). [7]

Antharmugam

It is a scissor like instrument sharpened on the inner side used to cut the fleshy portion or the skin. [7]

Vanjiilaisaththagam

It is a lancet with sharpened end resembling the *vanji* leaf (*Nochi* leaf). It is used for stab and scratch. [7]

Padisam

It is a kind of forceps, an angle like thin rod with a bent end and a handle at the other end used for holding fast the morbid growth or other syphilitic ulcers and the adjoining swollen parts for purposes of operation in the throat. [7]

Anguli

It is a flattened instrument, used to examine and to apply the medication over the throat. [7]

Thaarai

It is a probe like instrument with hole on the inside tube. It is made up of copper or silver metal. It is used to treat the disease conditions of *neeraamai*, *salaadaippu* to expel the accumulated water from the bladder. [7]



**Ponmozhi et al.,*****Veenai***

It is a probe like instrument and strong smooth wire like probe. It is used to detect the ulcers of ears and nose and expel the accumulated dirt. It is 6 or 9 inches long. [7]

Peechukuzhal

It is a bag like tube, used to insert the medicated decoctions, medicated oils to the body and to apply medicines over the wounds. [7]

Pottu

Pottu is a plug called as Tampon functioning like a *varthi*. It is made from wood cork. It is used for blocking the vaginal orifice or absorb the discharges from vaginal orifice.[8,12]

Kalachikol

It is a cauterizing rod used in surgery.[8]

Soottukol

It is a red-hot iron or hot needle for scaring the skin of children.[8]

Karupulikal

It is a cautery rod for scorching the morbid flesh. [8]

Padalaoosi

A needle for removing cataract. [8]

Utharakarisi

This stool is used to extraction of foetus head from the uterus.[15]

kuradugal

kuradugal (Forceps) was used during child labour for normal delivery.[15]

Sithirikathari

This tool is used to loosen the tightened muscle and used as scissors.[12]

Angusam

The tip of instrument will resemble the hook like structure which was used child labour for extraction of foetus.[12]

Mottaikuradu

It is used to extract the foetus head from the uterus.[12]

Sethagakuradu

This tools was used for the extraction of foetus during child labour.[13.2]

Piruma

Piruma is a surgical instrument used to incise and drain the abscess. It is inserted 2 inches into an abscess with fluid, inserted 3 inches into an abscess which contains soft flesh, inserted one inch in a hard abscess, inserted 5 inches into the abscess of lower legs and thighs, inserted 6 inches into an abscess which is open and hollow, inserted one inch in the abscess of the cheek, nose, mouth, inserted 4 inches into the groin abscess and inserted one inch in skin to cure *kiranthi* and *kuttam* diseases. [11]





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DISCUSSION

The primary aim of this review is through light in order to explore the evidence of *Siddha* surgical instruments in ancient days. This study reveals that various *Siddha* surgical instruments are used in different ways in the management of different conditions. Such as examination, application of medicines, normal delivery and many para-surgical procedures like as *aruvai*, *keeral* (Incision and draining), *kuruthivaangal* (Bloodletting), *salagaiyudal*, *thokkanam* (Massage), *varthi* (Medicated wick), *peechal* (Enema therapy), *pugai* therapy (Fumigation), *suttigai* therapy (Metal cauterization), *kaaram* (Chemical cauterization) under the *aruvai*, *agni* and *kaaraparigaram*. This review identified in more than 60 parasurgical instruments. Most of the instruments are used for incision and drainage purpose and to treat the various eye diseases. For example, *Padalam* (cataract), *Nagapadalam* (pterygium), staphyloma of the cornea, *Mudamayur* (trichiasis). *Vizhiunthal* (Disease of the black of the eye), *kanezhuchi* (Morbid growth in the eye), abscess, cyst, sinuses, wounds etc. The instruments are made up of copper, silver, brass, gold, lead. The sharp and blunted end instruments are used in ancient days. Sharp end instruments are used for cut, incision and drainage. Blunt end with opening like instruments are used for examination purposes. The end is hook like instruments are used for holding purposes. Gynecological instruments are *Utharakarisi*, *kuradugal*, *angusam*, *sithirikathari*, *mottaikuradu* are used for normal delivery in ancient days. The tip of instrument shapes is different in structures like as bird's legs, beak, reptiles, seeds, leaf, flowers, weapons, moon etc. eg., *Sathiram* - neem leaf, *PiraiKol* - half moon, *Kudori* - axe, teeth of cow, *Saari mugam* - birds beak, *Virigi* - paddy, *Uthpalam* - petal of lily, *Paambusathagam* - face of snake, *Vanjilaisathagam* - nochi leaf (*vitex negundo*), *Vilisam* - seed of *karunjeeragam* (*nigella sativa*), *Kaakai kaal* - crows leg, *Pulladi* - birds foot, *Thelliyakaruvu* - seeds of *ellu* (*Sesamum indicum*), *Pottusoottukol* - circular coin shape, *Azhisoottukol* - ring shape. The *Siddha* surgical ophthalmology is elaborately dealt in the texts *Agathiyarnayanavithi* and *Nagamuninayanavithi*. The instruments and methodology for cataract surgery is mentioned in *Agathiyarnayanavithi*. Some of the special surgical treatments mentioned for diseases like *Nagapadalam* (Pterygium), *Mayirpuzhuveettu* (Ulcerative blepharitis), *Amaram* (Ophthalmia neonatorum), *Mudamayir* (Trichiasis), etc. Most of the instruments are mentioned in literatures of *Agasthiyar*, *Nagamuni*, *Rajasegaram*, *Sambasivampillai* medical dictionary. 30 surgical instruments are mentioned in *Agathiyarnayanavithi* 500, 26 instruments are mentioned in *Agathiyar* 2000, 28 surgical instruments are mentioned in *Rajasekaram*, 2 instruments are mentioned in *Nagamuninayanavithi*, 8 instruments are mentioned in *Nagamunithalainoimaruthuvamandpararasasegaram*, 29 instruments mentioned in *Agathiyarviranakarappanrogasigichai*, 23 instruments are mentioned in *Sambasivampillai* medical dictionary. *Siddhars*, in ancient days performed *Aruvai*, *Agni* and *Karam* procedures by using *Siddha* surgical and para surgical instruments. In this study, 20 *Aruvai* instruments, 15 *Agni* instruments which are in various *Siddha* literature.

CONCLUSION

This present study reveals the *Siddha* system of medicine has promising evidence for ancient surgical instruments and surgical procedures in the management of various diseases. In the *Siddha* system, the documentation of surgical instruments is very limited. Nowadays the practical application of surgical instruments is less due to lack of literary evidence. So, I conclude this study reveals the information about the *Siddha* surgical instruments and procedures which may be useful for academic purposes and establishing *Siddha* surgical procedures in the management of various surgical conditions.

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Conflict of Interest

The authors have declared that no conflict of interest.

Author's Contributions

V.P-Original draft, R.K-Review and editing, P. Samundeshwari- Review& N.J. Muthukumar- Guide of this study

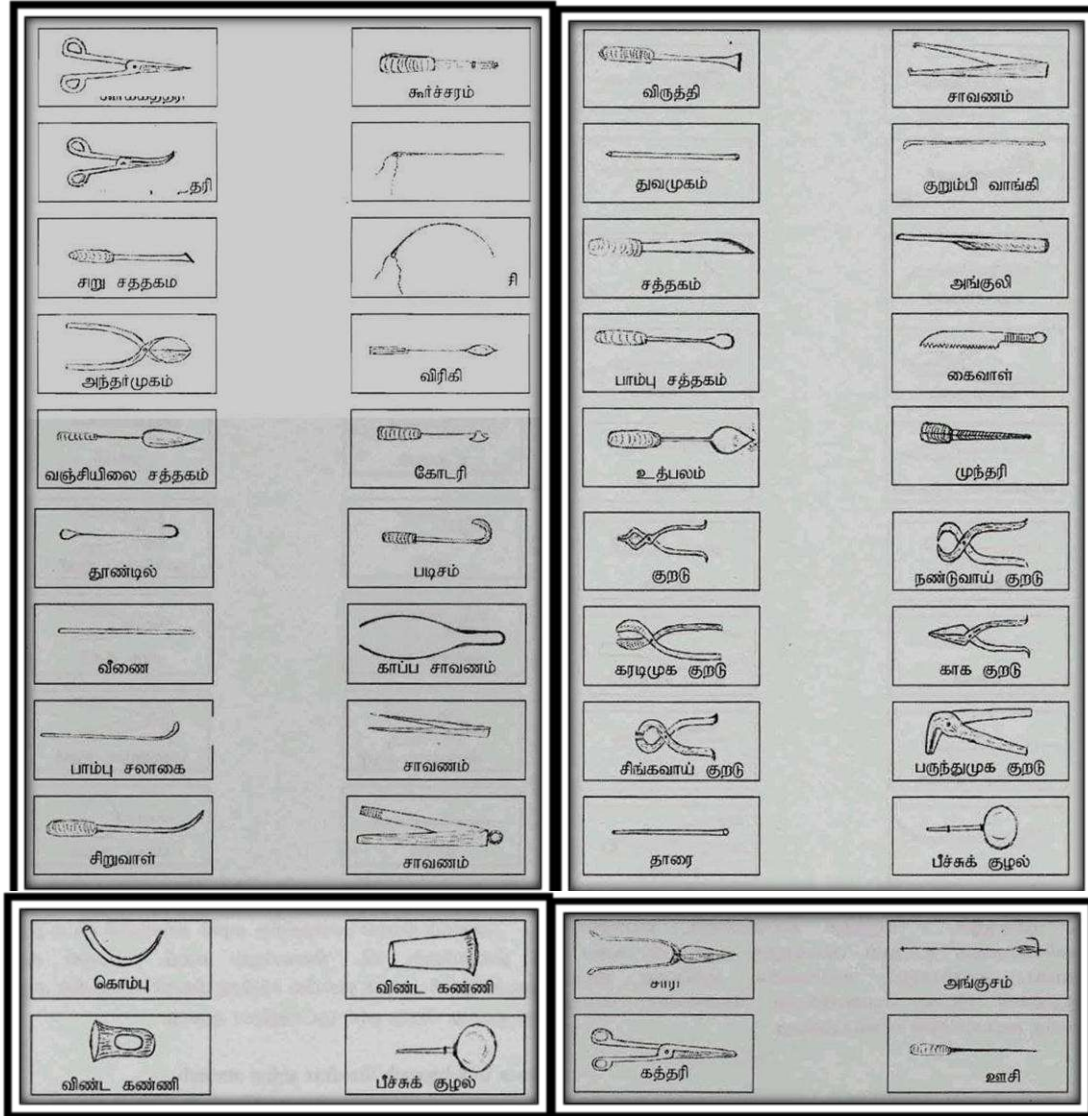
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Exploring the Multidimensional Landscape of Cultural Dimensions : An in-Depth Analysis of Mendez Cultural Dimensions and Cross-Cultural Leadership Effectiveness

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ABSTRACT

In the contemporary era of globalization, the Information Technology (IT) sector has emerged as a pivotal force shaping the modern business landscape. This study investigates the complex dynamics between Mendez cultural dimensions and cross-cultural leadership effectiveness within this diverse organizational context and examines how cultural tendencies influence leadership practices in multicultural environment. A quantitative survey involving 413 participants from the IT industry in Bangalore was conducted to assess Mendez's cultural dimensions and their impact on cross-cultural leadership effectiveness. Descriptive statistics revealed a generally high level of agreement across cultural dimensions, indicating a consistent perception among respondents. ANOVA results highlighted the significant effects of gender, language, age, and job description on cross-cultural leadership effectiveness, emphasizing the importance of these factors in shaping leadership practices. Construct validity and reliability analysis confirmed the reliability and validity of the measurement scales used in the study. Chi-square tests further elucidated associations between demographic variables, cultural dimensions, and leadership effectiveness, emphasizing the need for tailored leadership strategies in diverse cultural contexts. Regression analysis provided a robust prediction of Cross-Cultural Leadership Effectiveness based on the included variables. The findings underscore the importance of understanding and leveraging cultural diversity in the IT industry to enhance leadership effectiveness. Overall, this study contributes to advancing our understanding of cultural dimensions and their implications for effective leadership in multicultural organizational settings.

Keywords: Deirdre Mendez, Cross-cultural leadership, Cultural dimensions, Global leadership, Bangalore IT Sector.



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INTRODUCTION

In the contemporary era of globalization and rapid technological advancements, the Information Technology (IT) sector has emerged as a pivotal force shaping the modern business landscape. With increasing globalization, firms are expanding their operations across the globe and engaging in collaborations with overseas partners, resulting in the proliferation of culturally diverse organizations (Padilla, 2013). This global shift, driven by technological advancements, migration, and evolving opportunities, has led to the emergence of complex organizational structures characterized by cultural diversity (Dolan & Kawamura, 2015). As organizations become increasingly multicultural, understanding the dynamics of cross-cultural leadership becomes paramount for effective management of employee performance and satisfaction (HROne, 2023). The rapid progress and groundbreaking innovations witnessed in the IT domain have reshaped the operational landscape of businesses, necessitating continuous training and enhancement of the workforce to align with the evolving nature of the industry (M. Chethan et al., 2023). The urbanization in India, driven by globalization, liberalization, and privatization, has resulted in rapid population growth in cities like Bangalore, which experiences an annual population growth rate of 4.6 percent (Ramachandra, Aithal, & Sowmyashree, 2013). As the primary hub for administration, culture, commerce, industry, and education within the state of Karnataka, Bangalore's Information and Technology (IT) sector significantly contribute to employment, engaging 45 percent of the local workforce (Ramachandra & Aithal, 2019). This sector's paramount presence underscores its pivotal role in shaping the city's socio-economic dynamics and supporting livelihoods for a significant portion of the population. Furthermore, the IT industry's ability to offer higher per capita incomes underscores its substantial impact on the region's overall prosperity and standard of living.

Cross-cultural leadership is imperative for success within Bangalore's tech industry, characterized by global collaborations, virtual teams, and multifaceted projects. Effective cross-cultural leadership bridges cultural gaps and fosters a collaborative spirit that enhances team performance and innovation. Embracing cross-cultural leadership principles nurtures a sense of belonging among employees from diverse backgrounds, leading to increased job satisfaction and retention rates. In the context of Bangalore's tech ecosystem, cross-cultural leadership becomes the cornerstone of building successful, harmonious, and high-performing teams.

In the realm of cross-cultural leadership effectiveness within the diverse organizations, understanding of the intricacies of cultural dimensions is paramount. Deirdre Mendez, in her seminal work, has identified eight dimensions of culture that provide valuable insights into the complexities of cultural diversity and its impact on leadership effectiveness. Deirdre Mendez, renowned for her expertise in cross-cultural communication, has developed the ARC System, which identifies eight dimensions of culture. These dimensions capture the diverse ways in which cultures structure human interaction and activity. Understanding these dimensions is pivotal for leaders operating in multicultural environments, as they shape communication styles, decision-making processes, and organizational dynamics. This article examines Mendez's eight dimensions of culture and their implications for effective cross-cultural leadership.

Literature Review

As businesses expand globally, leaders must possess the skills to effectively manage diverse teams and adapt their leadership styles to different cultural contexts. Scholars and practitioners recognize the imperative of adapting leadership styles to accommodate cultural differences (McCauley & Palus, 2020). Over time, cross-cultural leadership research has progressed from early recognition of cultural disparities to sophisticated frameworks designed to enhance leadership effectiveness across diverse cultural contexts (Bird & Mendenhall, 2016). Cross-cultural leadership refers to the ability of leaders to work with people from different cultures and effectively manage their teams in a multicultural setting. As businesses expand globally, effective cross-cultural leadership becomes



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increasingly important (Liou & Rao- Nicholson, 2017). It involves interpreting and adopting diverse cultural conventions, beliefs, and communication patterns to forge strong connections with individuals from various cultural backgrounds (Amagoh, 2009).

In a globalized world, effective cross-cultural leadership is an important aspect for the organizational success. Leaders may have to adapt to the various leadership styles to facilitate different cultural contexts facilitate communication, build trust, and create a sense of belonging among team members from diverse backgrounds (Kyove et al., 2021). On the other hand, ineffective cross-cultural leadership can lead to misunderstandings, conflicts, and decreased morale among employees, ultimately affecting business performance. Mendez emphasizes the importance of recognizing cultural diversity and adapting leadership styles to accommodate different cultural contexts (Mendez, 2017). Her framework provides insights into how cultural dimensions influence leadership effectiveness in multicultural settings, highlighting the significance of cultural intelligence, communication skills, emotional intelligence, and intercultural competence. Deirdre Mendez's comprehensive exploration of cultural dimensions in her book *The Culture Solution* & (2019) presents an understanding of how cultural tendencies influence various aspects of communication, emotion expression, social hierarchy, group dynamics, decision-making, action approach, and organizational structure. These dimensions play a crucial role in shaping cross-cultural leadership effectiveness, particularly in dynamic and diverse settings such as the IT industry in Bangalore.

Mendez's cultural dimension of clarity underscores the divergence in communication styles across different cultures. While some cultures prefer direct communication marked by explicit messages, others lean towards indirect communication, relying on subtle cues to convey meaning (Mendez, 2017). Leaders operating in cross-cultural contexts, especially within the IT industry in Bangalore, must navigate these communication styles to facilitate effective collaboration and understanding among team members (Mendez, 2017). Within Mendez's framework, the dimension of emotion highlights the variance in emotional expressiveness across cultures. Cultures with neutral tendencies exhibit controlled emotional displays, while expressive cultures openly and vividly express emotions (Mendez, 2017). Leaders who comprehend and adapt to these emotional tendencies can foster a conducive work environment that encourages open communication, collaboration, and innovation.

Mendez's cultural dimension of status delves into how cultures perceive and interact with social hierarchies. Achievement-based cultures value meritocracy, while endowment-based cultures emphasize factors like loyalty and background in determining social standing (Mendez, 2017). Understanding these status tendencies is essential for cross-cultural leaders in navigating hierarchical structures and decision-making processes. The involvement dimension in Mendez's model explores how cultures engage in group processes and decision-making. Network-oriented cultures prioritize personal contacts, while process-oriented cultures focus on dependable systems and structures (Mendez, 2017). Cross-cultural leaders must be aware of these involvement tendencies to facilitate effective collaboration and decision-making within multicultural teams.

Mendez's framework categorizes collaboration tendencies into independent and group orientations. Independent cultures emphasize individual accountability, while group-oriented cultures prioritize collective efforts (Mendez, 2017). Leaders operating in cross-cultural environments must recognize and accommodate these collaboration tendencies to foster teamwork and achieve organizational goals effectively. In Mendez's model, authority tendencies encompass rule orientation and situation orientation. Rule-oriented cultures adhere to hierarchical structures and formal procedures, while situation-oriented cultures adopt a flexible approach to authority and decision-making (Mendez, 2017). Cross-cultural leaders must navigate these authority tendencies to establish effective leadership and decision-making processes within diverse cultural contexts.

Mendez's cultural dimension of action delineates cultural preferences for task approach and decision-making. Opportunity-oriented cultures encourage agility and risk-taking, while thoroughness-oriented cultures prioritize systematic planning and risk aversion (Mendez, 2017). Understanding these action tendencies enables cross-cultural leaders to adapt their leadership styles and decision-making approaches to suit diverse cultural contexts. The



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organization dimension in Mendez's model explores cultural preferences for work structure and management. Schedule-oriented cultures prioritize precision and adherence to fixed timelines, while flow-oriented cultures emphasize adaptability and spontaneity (Mendez, 2017). Cross-cultural leaders must consider these organizational tendencies when structuring work processes and managing teams in multicultural settings.

An effective cross-cultural leadership is indispensable in today's globalized world. Leaders must possess the skills to navigate cultural diversity, adapt their leadership styles, and foster inclusivity within their organizations. By understanding and leveraging cultural diversity, organizations can enhance productivity, foster innovation, and achieve sustainable growth in an increasingly interconnected world.

METHODOLOGY

A quantitative survey of 413 participants in the IT industry in Bangalore was conducted, assessing Mendez's cultural dimensions and cross-cultural leadership effectiveness. Statistical analyses included frequency distributions, ANOVA, discriminant validity tests, and regression analysis. These methods elucidated the distribution patterns, impact of demographic variables, construct validity, and predictive power of cultural dimensions on leadership effectiveness. The findings contributed to a comprehensive understanding of the complex dynamics between cultural dimensions and cross-cultural leadership.

FINDINGS AND ANALYSIS

The descriptive statistics of Mendez Cultural Dimensions, as shown in Table 1, provide valuable insights into the cultural tendencies among the participants. With a sample size of 413, the mean scores indicate a generally high level of agreement across all dimensions, ranging from 4.38 to 4.46. The median and mode scores of 4 further confirm the central tendency of the data, suggesting a consistent perception of cultural dimensions among respondents. The standard deviation values, ranging from 0.514 to 0.553, indicate moderate variability around the mean, highlighting some level of dispersion in responses. Additionally, the variance values, ranging from 0.264 to 0.302, further support this notion of dispersion within the data. Skewness values close to zero (-0.268 to -0.021) suggest a relatively symmetrical distribution of data, while kurtosis values within the acceptable range (-1.613 to 2.138) indicate normal or moderately peaked distributions. Overall, the findings suggest a relatively homogeneous perception of Mendez Cultural Dimensions among the participants, with minor variations observed across dimensions. These results provide a foundational understanding of the cultural landscape within the studied context, laying the groundwork for further analysis on the impact of these dimensions on cross-cultural leadership effectiveness.

ANOVA Results for Mendez Cultural Dimensions and Cross-Cultural Leadership Effectiveness

The results indicate significant effects of several cultural dimensions on cross-cultural leadership effectiveness. Specifically, gender ($F = 20.664$, $p < .001$), language ($F = 6.339$, $p < .001$), and age ($F = 4.835$, $p < .001$) demonstrate statistically significant effects. However, job description ($F = 2.992$, $p = .019$) also exhibits a significant effect, albeit with a slightly higher

p-value.

Conversely, education qualification, total experience, annual income, aspiration level, workload, and work meaningfulness do not show statistically significant effects on cross-cultural leadership effectiveness at the conventional significance level ($p < .05$). These findings emphasize the significance of gender, language, age, and job description in shaping cross-cultural leadership effectiveness within the framework of Mendez Cultural Dimensions. Understanding and addressing these dimensions can contribute to more effective leadership practices in multicultural settings.



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The results indicate significant effects on cross-cultural leadership effectiveness for certain cultural dimensions. Gender stands out as highly influential ($F = 19.224$, $p < .001$), highlighting its pivotal role in determining leadership effectiveness across cultures. Similarly, language shows a noteworthy effect ($F = 4.631$, $p = .001$), emphasizing the importance of linguistic considerations in cross-cultural leadership contexts. Moreover, age ($F = 5.190$, $p < .001$) and aspiration level ($F = 1.210$, $p = .291$) demonstrate statistically significant effects on leadership effectiveness, although the impact of aspiration level is relatively weaker. Conversely, job description, education qualification, total experience, annual income, workload, and work meaningfulness do not exhibit significant effects on cross-cultural leadership effectiveness at the conventional significance level ($p < .05$). These findings underscore the importance of gender, language, age, and aspiration level in shaping cross-cultural leadership effectiveness, providing valuable insights for organizations striving to enhance leadership practices in diverse cultural contexts.

The present study delved into the intricate interplay between Mendez Cultural Dimensions and Cross-Cultural Leadership Effectiveness, utilizing a sample size of 413 participants. Through an analysis of variance (ANOVA), the investigation revealed a significant relationship between these two constructs ($F(14) = 157.807$, $p < .001$). Specifically, the ANOVA yielded a substantial mean square value of 605.114, suggesting considerable variance attributed to the comparison between Mendez Cultural Dimensions and Cross-Cultural Leadership Effectiveness. This finding underscores the importance of understanding and integrating cultural dimensions within the context of leadership effectiveness across diverse cultural settings. The implications of these results extend to organizational contexts, emphasizing the significance of cultural competence and awareness in promoting effective cross-cultural leadership practices. Further research and practical interventions informed by these findings hold promise in fostering inclusive and culturally sensitive leadership strategies in globalized work environments. Construct Validity – Reliability and Validity Test

The table displays the factor loadings of variables for cross-cultural leadership effectiveness and Mendez cultural dimensions. Empowerment, with a high loading of 0.747, signifies its significant role in fostering effective leadership across diverse cultural contexts. Agreement, also showing a strong loading of 0.730, contributes to consensus-building and harmonious relationships within multicultural teams. Strategic Direction, with a notable loading of 0.837, emphasizes the importance of clear strategic vision in leading diverse teams effectively. Additionally, Team Building, with a strong loading of 0.742, fosters cohesion and synergy among multicultural team members. Change, with a relatively lower loading of 0.691, still plays a role in managing and adapting to cultural differences within dynamic environments. Goals and Objectives, with a moderate loading of 0.584, plays a role in providing direction and alignment in multicultural teams, albeit to a lesser extent compared to other variables. Capabilities exhibit a strong loading of 0.834, emphasizing the importance of possessing the necessary skills and competencies to lead effectively across diverse contexts. Share Values and Vision both demonstrate moderate loadings of 0.720 and 0.721, respectively, highlighting the significance of shared cultural values and a clear, inspiring vision in promoting cohesion and guiding effective cross-cultural leadership. Learning, with a strong loading of 0.836, underscores the importance of continuous learning and adaptability in enhancing cross-cultural leadership effectiveness. Additionally, Consumer Needs and Coordinate exhibit moderate to strong loadings of 0.684 and 0.850, respectively, indicating the relevance of understanding consumer preferences and coordinating efforts across multicultural teams for effective leadership in diverse cultural settings. These findings illuminate the multifaceted nature of cross-cultural leadership, emphasizing the importance of various dimensions in achieving effectiveness across diverse cultural contexts.

The factor loadings for Mendez Cultural Dimensions reveal several key insights into factors influencing cross-cultural leadership effectiveness. Clarity exhibits a high loading (0.925), emphasizing the significance of clear communication and vision in guiding multicultural teams. Involvement demonstrates a remarkably high loading (0.979), highlighting its crucial role in engaging diverse team members and fostering inclusivity. Authority (0.962) underscores its importance in establishing leadership legitimacy and direction within multicultural settings. Collaboration (0.979) emphasizes teamwork and synergy among individuals from diverse backgrounds. Emotion (0.499) shows a relatively lower loading but remains pertinent for fostering positive relationships. Action (0.924)



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highlights proactive decision-making, while Status (0.944) and Organization (0.945) stress understanding social dynamics and maintaining structured processes, respectively, all contributing to effective cross-cultural leadership. Understanding these factor loadings provides valuable insights into the mendez dimensions that significantly contribute to cross-cultural leadership effectiveness. These findings can inform leadership development programs and interventions aimed at enhancing multicultural leadership capabilities.

Table 6 presents the results of the construct validity and reliability analysis for both Cross- Cultural Leadership Effectiveness and Mendez Cultural Dimensions. The Cronbach's alpha values for Cross-Cultural Leadership Effectiveness (0.934) and Mendez Cultural Dimensions (0.964) indicate high internal consistency and reliability of the measured constructs. Additionally, the composite reliability coefficients (ρ_a and ρ_c) are above the threshold of 0.7 for both constructs, further confirming their reliability. The average variance extracted (AVE) values for Cross-Cultural Leadership Effectiveness (0.565) and Mendez Cultural Dimensions (0.823) exceed the recommended threshold of 0.5, indicating convergent validity. These findings suggest that the measurement scales used to assess both constructs are reliable and valid, supporting their suitability for examining the relationship between cultural dimensions and leadership effectiveness in diverse contexts.

The Chi-Square test results in Table 7 reveal significant associations between Mendez Cultural Dimensions (MCD) and demographic variables. Notably, the p-values indicate statistical significance for several variables. Age interaction with MCD ($p = 0.016$) suggests that age influences perceptions of cultural dimensions. Similarly, significant associations are found for Education Qualification ($p < 0.001$), Gender ($p = 0.008$), Language ($p = 0.001$), and Annual Income ($p < 0.001$) with MCD. However, Job Description, Total Experience, Aspiration Level, Workload, and Work Meaningfulness show non-significant associations. These findings suggest that demographic factors play a crucial role in shaping perceptions of cultural dimensions, highlighting the need for tailored leadership strategies in diverse cultural contexts. These results provide valuable insights into understanding the multidimensional landscape of cultural dimensions and its implications for cross-cultural leadership effectiveness.

Table 8 presents the results of the Chi-Square tests examining the relationship between Cross- Cultural Leadership Effectiveness (CCLT) and demographic variables. The findings indicate statistically significant associations between CCLT and several demographic factors. Specifically, Age ($p < 0.001$), Gender ($p = 0.021$), Total Experience ($p = 0.019$), Language ($p < 0.001$), Annual Income ($p = 0.001$), Aspiration Level ($p = 0.021$), and Work Meaningfulness ($p = 0.038$) demonstrate significant associations with CCLT. These results suggest that demographic variables play a crucial role in shaping perceptions of cross-cultural leadership effectiveness. Interestingly, while Job Description, Education Qualification, and Workload show non-significant associations with CCLT, the Mendez Cultural Dimensions exhibit a highly significant association ($p < 0.001$), indicating the strong influence of cultural dimensions on cross-cultural leadership effectiveness. These findings underscore the importance of considering demographic variables and cultural dimensions in understanding and enhancing cross-cultural leadership effectiveness.

Regression

The model demonstrates a strong overall fit, with an R-squared value of 0.923, indicating that approximately 92.3% of the variance in CCLT can be explained by the predictor variables included in the model. The adjusted R-squared value of 0.848 suggests that this model accounts for 84.8% of the variance in CCLT after adjusting for the number of predictors. The standard error of the estimate is 1.902197, indicating the average deviation of the observed values from the predicted values. Overall, these findings suggest that the model provides a robust prediction of Cross-Cultural Leadership Effectiveness based on the included variables, highlighting the importance of these factors in shaping leadership effectiveness across diverse cultural contexts.



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CONCLUSION AND FUTURE SCOPE

The findings from the comprehensive analysis of Mendez Cultural Dimensions and Cross-Cultural Leadership Effectiveness provide valuable insights into the complex interplay between cultural dimensions, demographic variables, and leadership effectiveness in diverse organizational settings. Descriptive statistics revealed a generally high level of agreement across Mendez Cultural Dimensions among participants, indicating a consistent perception of cultural dimensions. ANOVA results highlighted the significant effects of gender, language, age, and job description on cross-cultural leadership effectiveness, underscoring the importance of these factors in shaping leadership practices in multicultural contexts. Additionally, the construct validity and reliability analysis confirmed the reliability and validity of the measurement scales used to assess cultural dimensions and leadership effectiveness. The Chi-Square test results further elucidated the associations between demographic variables, cultural dimensions, and leadership effectiveness, emphasizing the need for tailored leadership strategies in diverse cultural contexts. Regression analysis provided a robust prediction of Cross-Cultural Leadership Effectiveness based on the included variables, highlighting their critical role in determining leadership effectiveness across diverse cultural landscapes. Moving forward, further research could explore the moderating effects of contextual factors such as organizational culture, industry type, and geographical location on the relationship between cultural dimensions and leadership effectiveness. Additionally, longitudinal studies could provide insights into the dynamic nature of cultural dimensions and their evolving impact on leadership effectiveness over time. Moreover, qualitative research methods such as interviews and focus groups could offer deeper insights into the underlying mechanisms driving the observed relationships between cultural dimensions, demographic variables, and leadership effectiveness. Furthermore, interventions and training programs aimed at developing cultural intelligence and cross-cultural leadership competencies could be designed and evaluated to enhance leadership effectiveness in multicultural settings. Overall, continued research in this area is essential for advancing our understanding of the multidimensional landscape of cultural dimensions and its implications for effective leadership in diverse organizational contexts.

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Table 1: Descriptive Statistics of Mendez Cultural Dimensions

N =413	Clarity	Emotion	Status	Involvement	Collaboration	Authority	Action	Organization
Mean	4.46	4.38	4.45	4.46	4.46	4.46	4.45	4.46
Median	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Mode	4	4	4	4	4	4	4	4
Std. Deviation	.532	.543	.549	.514	.514	.527	.553	.532
Variance	.283	.294	.302	.264	.264	.278	.306	.283
Skewness	-.268	-.153	-.651	-.021	-.021	-.139	-.398	-.268
Kurtosis	-.535	-.339	2.138	-1.613	-1.613	-1.323	-.341	-.535
Minimum	2	2	1	3	3	3	2	2
Maximum	5	5	5	5	5	5	5	5

Table 2: ANOVA Results for Mendez Cultural Dimensions

	N = 413	Sum of Squares	df	Mean Square	F	Sig.
Mendez	Age	270.559	4	67.640	4.835	<.001
	Job Description	170.360	4	42.590	2.992	.019
	Education Qualification	52.363	3	17.454	1.205	.308
	Gender	286.174	1	286.174	20.664	<.001
	Total Experience	76.666	4	19.166	1.325	.260
	Language	349.781	4	87.445	6.339	<.001
	Annual Income	64.025	4	16.006	1.104	.354
	Aspiration Level	137.479	8	17.185	1.189	.304
	Workload	82.035	4	20.509	1.419	.227
	Work Meaningfulness	61.622	4	15.405	1.062	.375

Table 3: ANOVA Results for Cross Cultural Leadership

	N = 413	Sum of squares	df	Mean Square	F	Sig.
Cross Cultural Leadership Effectiveness	Age	484.115	4	121.029	5.190	<.001
	Job Description	190.006	4	47.502	1.976	.097
	Education Qualification	127.966	3	42.655	1.768	.153
	Gender	446.732	1	446.732	19.224	<.001
	Total Experience	174.256	4	43.564	1.809	.126
	Language	434.162	4	108.541	4.631	.001
	Annual Income	127.203	4	31.801	1.314	.264
	Aspiration Level	233.961	8	29.245	1.210	.291
	Workload	113.696	4	28.424	1.173	.322
	Work Meaningfulness	80.692	4	20.173	.830	.507

Table 4: ANOVA for Mendez Cultural Dimensions vs. Cross Cultural Leadership Effectiveness

N = 413	Sum of Squares	df	Mean Square	F	Sig.
Mendez Cultural Dimensions Vs Cross Cultural Leadership Effectiveness	8471.593	14	605.114	157.807	<.001





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Table 5: Factor Loadings of Variables for Cross-Cultural Leadership

Variables	Outer Loading	Variables	Outer Loading	Variables	Outer Loading	Variables	Outer Loading
Empowerment	0.747	Agreement	0.73	Strategic Direction	0.837	Involvement	0.979
Team Building	0.742	Change	0.691	Goals and Objectives	0.584	Collaboration	0.979
Capabilities	0.834	learning	0.836	Clarity	0.925	Authority	0.962
Coordinate	0.85	Consumer Needs	0.684	Emotion	0.499	Action	0.924
ShareValues	0.72	Vision	0.721	Status	0.944	Organization	0.945

Table 6: Construct Validity and Reliability Analysis

N = 413	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Cross Cultural Leadership Effectiveness	0.934	0.961	0.939	0.565
Mendez Cultural Dimensions	0.964	0.968	0.973	0.823

Table 7: Chi-Square Test Results for Mendez Cultural Dimensions and Demographic Variables

	N = 413	Value	df	Asymptotic Significance(2-sided)
Mendez Cultural Dimensions	Age	80.951 ^a	56	.016
	Job Description	44.867 ^a	56	.857
	Education Qualification	99.822 ^a	42	<.001
	Gender	29.682 ^a	14	.008
	Total Experience	62.302 ^a	56	.262
	Language	93.981 ^a	56	.001
	Annual Income	132.158 ^a	56	<.001
	Aspiration Level	123.357 ^a	112	.218
	Workload	93.350 ^a	56	.001
	Work Meaningfulness	89.864 ^a	56	.003



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Table 8: Chi-Square Test Results for Cross Cultural Leadership Effectiveness and Demographic Variables

N = 413		Value	df	Asymptotic Significance (2-sided)
Cross Cultural Leadership Effectiveness	Age	117.020 ^a	72	<.001
	Job Description	80.433 ^a	72	.232
	Education Qualification	53.315 ^a	54	.501
	Gender	32.191 ^a	18	.021
	Total Experience	99.165 ^a	72	.019
	Language	121.713 ^a	72	<.001
	Annual Income	113.489 ^a	72	.001
	Aspiration Level	180.445 ^a	144	.021
	Workload	88.042 ^a	72	.096
	Work Meaningfulness	94.602 ^a	72	.038
	Age	1504.283 ^a	252	<.001

Table 9: Regression Analysis for Predicting Cross-Cultural Leadership Effectiveness

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.923 ^a	.853	.848	1.902197

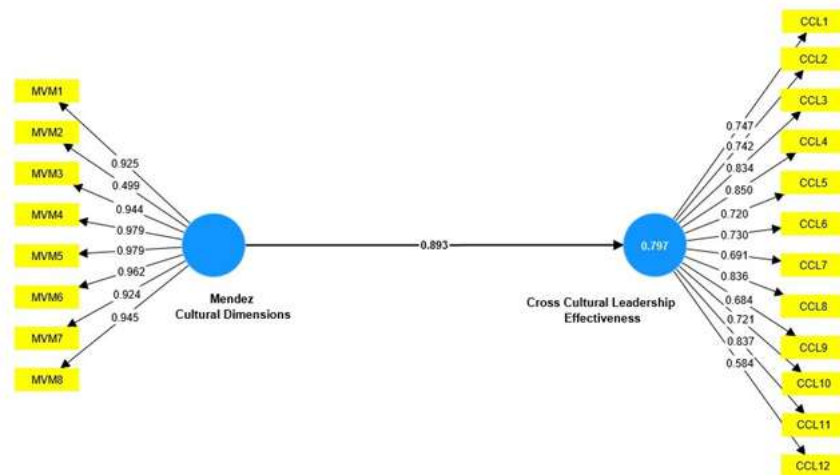


Figure 1: Factor Loadings of Mendez Cultural Dimensions on Cross-Cultural Leadership Effectiveness





Knowledge Mining From Data Extracting and Warehousing

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ABSTRACT

Data Mining refers to lodging or “Mining” knowledge from large amounts of data. Data Mining should be considered “Knowledge mining from data”, which is unfortunately kind of long. “Knowledge mining”, a shorter term may not reflect the emphasis on mining from large amounts of data. The similar meaning to data mining, analogous as knowledge mining from data, knowledge birth, data pattern analysis, data archaeology, and data dredging. It's also a rear for, Knowledge Discovery from Data (KDD). Data patterns can be mine from multitudinous different kinds of databases, analogous as relational databases, data warehouses, and transactional, and object- relational databases. Interesting data patterns can also be lodging from other kinds of information magazines, including spatial, time- series, sequence, text, multimedia, and heritage databases, data courses, and the World Wide Web. This paper explains the architecture of data mining and data storage, and deals the recent trends in data mining and the some current operations of data mining.

Keywords: Knowledge Discovery, Knowledge Mining

INTRODUCTION

Database technology has evolved from savages train processing to the development of database operation systems with query and transacting processing. Further progress has led to the adding demand for effective and effective advanced data analysis tools. This need is a result of the explosive growth in data collected from operations,





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including business and operation, government administration, wisdom and engineering, and terrain control. Data mining is the task of discovering intriguing patterns from large quantities of data, where the data can be stored in databases, data storages, or other information depositories. It's a youthful interdisciplinary field, drawing from areas similar as database systems, data warehousing statistics, machine literacy, data visualization, information reclamation, and high- performance computing. Other contributing areas include neural networks, pattern recognition, spatial, data analysis, image databases, signal processing, and numerous operation fields, similar as business, economics, and bioinformatics. The armature of a typical data mining system includes a database and/ or data storehouse and their applicable waiters, a data- mining machine and pattern evaluation module, and a graphical stoner interface. Integration of the data mining factors, as a whole, with a database or data storehouse system can involve no coupling, loose coupling, semi tight coupling, and tight coupling.

Description of Data Mining

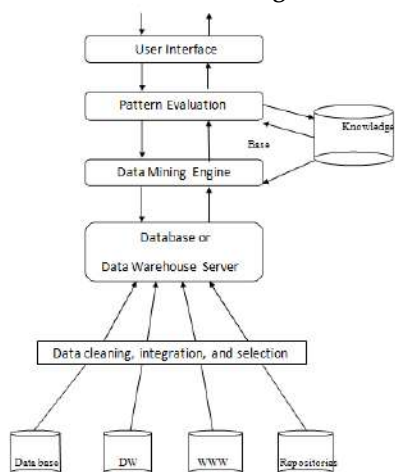
Data mining is the process of discovering meaningful new correlation pattern and trains by shifting to large quantum of data stored in depositories using pattern recognition using pattern recognition fashion and fine ways. Data mining is the process for relationship and global patterns that was large databases but hidden among vast quantum of data.

Architecture of a Data Mining

Components of Data Mining

1. Database, data warehouse, WWW, other repositories
2. Database or data warehouse server
3. Knowledge base
4. Data mining engine
5. Pattern evaluation module
6. User interface

Architecture of Data Mining



Data Mining Task Primitives

A data-mining task can be specifying in the form of a data-mining query, which is the input to the data mining system. A data-mining query defined in terms of data mining task primitives. These primitives allow the user to communicate with the data mining system during discovery in order to direct the mining process, or examine the findings from different angles or depths.





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Primitives For Data Mining

1. Task-relevant data
2. Knowledge type to be mined
3. Background knowledge
4. Interestingness measures and thresholds for pattern evaluation
5. Representation for visualization

Data Warehouse

Data storehouse defined in numerous ways, making it delicate to formulate a rigorous description. A data storehouse is a subject acquainted, integrated, time-variant, and non-volatile collection of data in support of operation's decision- making process.

Way for Design a Data Storehouse

1. A Business Analysis frame A data storehouse may give a competitive advantage by presenting applicable information from which to measure performance and make critical adaptations in order to help win over challengers. A data storehouse can enhance business productivity because it's suitable to capability and efficiently gather information that directly describes the association. A data storehouse facilitates client relationship operation because it provides a harmonious view of guests and particulars across all lines of business, all departments, and all requests. A data storehouse may bring about cost reduction by tracking trends, patterns, and exceptions over long ages in a harmonious and dependable manner.
2. To design effective data storehouse we need to understand and dissect business requirements construct a business frame. The construction of a large and complex information system can be view as the construction of a large and complex structure, for which the proprietor, mastermind, and builder have different views. Four different views regarding the design of a data storehouse must considered the top- view, the data source view, the data storehouse view, and the business query view.
3. The process of Data Warehouse Design A data storehouse can be make using a top-down approach, a bottom- up approach, or a combination of both. The top-down approach starts with the overall design and planning. It's useful in cases where the technology is mature and well known, and where the business problems that must answered are clear and well understood. The bottom- up approach starts with trials and prototypes. In the combined approach, an association can exploit the planned and strategic nature of the top-down approach while retaining the rapid-fire perpetration and opportunistic operation of the bottom- up approach.
4. The cascade system performs a structured and methodical analysis at each step before pacing to the coming, which is like a cascade, falling from one- step to the coming. The helical system involves the rapid-fire generation of decreasingly functional systems, with short intervals between consecutive releases. This is consider to a good choice for data storehouse development, especially for data marts, because the reversal time is short, variations can be done snappily, and new designs and technologies can be acclimated in a timely manner.
5. A Three- Tier Data Warehouse Architecture Data storehouse frequently borrow a three- league armature
6. The nethermost league is a storehouse database garçon that's always a relational database system. Back- end tools and serviceability used to feed data into the bottom league from functional databases or other external sources. These tools and serviceability perform data birth, cleaning, and metamorphosis, as well as cargo and refresh functions to modernize the data storehouse. The data are uprooted using operation program interfaces known as gateways. A gateway was supporting by the underpinning DBMS and allows customer programs to induce SQL law to execute at a garçon.
7. The middle league is an OLAP garçon that's generally enforced using moreover(1) a relational OLAP(ROLAP) model, that is, an extended relational DBMS that maps operations on multidimensional data to standard relational operations; or(2) a multidimensional OLAP(MOLAP) model, that is, a special- purpose garçon that directly implements multidimensional data and operations.
8. The top league is a frontal- end customer subcaste, which contains query and reporting tools, analysis tools, and/ or data mining tools(e.g., trend analysis, vaticination, and so on). From the armature point of view, there are three data storehouse models the enterprise storehouse, the data emporium, and the virtual storehouse.





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9. Data Warehouse Back- end Tools and Utilities Data storehouse systems use back- end tools and serviceability include the following functions Data birth, which generally gathers data from multiple, miscellaneous, and external sources. Data drawing, which detects crimes in the data rectifies them possible.

10. Data metamorphosis, which converts data from heritage or host format to storehouse format. cargo, which sorts, summarizes, consolidates, cipher views, checks integrity, and builds indicators and partitions. Refresh, which propagates the updates from the data sources to the storehouse.

11. Metadata Repository Metadata are data about data. When used in a data storehouse, metadata are the data that's define storehouse objects. Metadata has created for the data names and delineations of the given storehouse. fresh metadata are created and captured for time stamping any uprooted data, the source of the uprooted data, and missing fields that have been added by data drawing or integration processes.

12. A data storehouse contains different situations of summarization, of which metadata is one type. Other types include current detailed data, smoothly epitomized data and largely epitomized data. Metadata play a veritably different part than other data storehouse data and are important for numerous reasons. For illustration, metadata are used as a directly to help the decision support system critic detect the contents of the data storehouse, as a companion to the mapping of data when the data are converted from the functional terrain to the data storehouse terrain, and as a companion to the algorithms used for summarization between the current detailed data and the largely epitomized data, and between the smoothly epitomized data and the largely epitomized data. Metadata should be stored and managed persistently.

A metadata repository should contain the following:

- ✓ The structure of the data warehouse
- ✓ Operational metadata
- ✓ Algorithms used for summarization
- ✓ Mapping from the operational environment to the data warehouse
- ✓ Data related to system performance
- ✓ Business metadata

Trends In Data Mining

The diversity of data, data mining tasks, and data mining approaches poses numerous grueling exploration issues in data mining. The development of effective and effective data mining styles and systems, the construction of interactive and intertwined data mining styles and systems, the construction of interactive and intertwined data mining surroundings, the design of data mining languages, and the operation of data mining experimenters end data mining system and operation inventors. Some of the trends.

- Operation disquisition Early data mining operations concentrated substantially on helping business gain a competitive edge. The disquisition of data mining for business continues to expand, ase-commerce and e marketing have come mainstream rudiments of the retail assiduity. Data mining has used for the disquisition of operations in other areas, similar as fiscal analysis, telecommunications, biomedicine, and the wisdom.
- Arising operation areas include data mining for counterterrorism and mobile data mining. As general data mining systems may have limitations in dealing with operation-specific problems, we may see a trend toward the development of further operation-specific data mining systems.
- Scalable and interactive data mining styles In discrepancy with traditional data analysis styles, data mining must be suitable to handle huge quantities of data efficiently and, if possible, interactively. Because the quantum of data being collect continues to increase fleetly, scalable algorithms for individual and intertwined data mining functions come essential. One important direction toward perfecting the overall efficiently of the data mining process while adding stoner commerce is constraint- grounded mining. This provides druggies with added control by allowing the specification and use of constraints to guide data mining systems in their hunt for intriguing patterns.
- Visual data mining Visual data mining is an effective way to discover knowledge from huge quantities of data. The methodical study and development of visual data mining ways will grease the creation and use of data mining as a tool for data analysis.





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- Biological data mining Although natural data mining can be consider under “ operation disquisition ” or “ mining complex types of data, ” the unique combination of complexity, uproariousness, size, and significance of natural data clearances special attention in data mining.
- Web mining Given the quantum of information available on the web and the decreasingly important part that the web plays in moment’s society, web content mining, weblog mining, and data mining services on the Internet will come one of the most important and flourishing subfields in data mining.
- Distributed data mining Traditional data mining styles, designed to work at a centralized position, don't work well in numerous of the distributed computing surroundings present moment. Advances in distributed data mining styles are anticipated.
- Real- time or time critical data mining numerous operations involving sluice data bear dynamic data mining models to be erecting in real time. fresh development is need in this area.

Operations of Data Mining

Data mining for the Telecommunication Industry

The telecommunication assiduity has snappily evolved from offering original and long- distance telephone services to furnishing numerous other comprehensive dispatches services, including fax, pager, cellular phone, Internet runner, images, e-mail, computer and Web data transmission, and other data business. The integration of telecommunication, computer network, Internet, and multitudinous other means of communication and computing is also underway. also, with the deregulation of the telecommunication assiduity in numerous countries and the development of new computer and communication technologies, the telecommunication request is fleetly expanding and largely competitive. This creates a great demand for data mining in order to help understand the business involved, identify telecommunication patterns, catch fraudulent conditioning, make better use of coffers, and ameliorate the quality of service.

The following are a many scripts for which data mining may ameliorate telecommunication services

- ❖ Multidimensional analysis of telecommunication data Telecommunication data are naturally multidimensional, with confines similar as calling- time, duration, position of frequenter, position of callee, and type of call. The multidimensional analysis of similar data can be used to identify and computer the data business, system workload, resource operation, stoner group geste and profit. For illustration, analysis, in the assiduity may wish to chronicity view maps and graphs regarding calling source, destination, volume, and time- of- day operation patterns. thus, it's frequently useful to consolidate telecommunication data into large data storages and routinely perform multidimensional analysis using OLAP and visualization tools.
- ❖ Fraudulent pattern analysis and the identification of unusual patterns Fraudulent exertion costs the telecommunication assiduity millions of bones per time. It's important to(1) identify potentially fraudulent druggies and their a typical operation patterns;(2) descry attempts to gain fraudulent entry to client accounts, and(3) discover unusual patterns that may need special attention, similar as busy- hour frustrated call attempts, switch and route traffic patterns, and periodic calls from automatic dial- eschewal outfit that have been inaptly programmed. numerous of these patterns can be discover by multidimensional analysis, cluster analysis, and outlier analysis.
- ❖ Multidimensional association and succession pattern analysis The discovery of association and succession patterns in multidimensional analysis can be use to promote telecommunication services. For illustration, suppose you would like operation patterns for a set of communication services by client group, by month, and by time of day.
- ❖ The calling records may be grouped by client in the following form Mobile telecommunication services Mobile telecommunication, Web and information services, and mobile computing are getting decreasingly integrated and common in our work and life. One important point of mobile telecommunication data is its association with spatiotemporal information. Spatiotemporal data mining may mobile phone business at certain locales may indicate commodity abnormal passing in these locales. also, ease of use is pivotal for enticing guests to borrow new mobile services. Data mining will probably play a major part in the design of adaptive results enabling druggies to gain useful information with many keystrokes.



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- ❖ Use of visualization tools in telecommunication data analysis Tools for OLAP visualization, relation visualization; association visualization, clustering, and outlier visualization have been shown to be useful for telecommunication data analysis.

CONCLUSION

Data pre-processing is an important issue for both data warehousing and data mining, as real-world data tend to be deficient, noisy, and data inconsistent. Data pre-processing includes data cleaning, data integration, data metamorphosis, and data reduction. Trends in data mining include further efforts toward the disquisition of new operation areas, bettered scalable and interactive styles, and the integration of data mining with data warehousing and database systems, the standardization of data mining languages, visualization styles, and new styles for handling complex data types.

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Effectiveness of Therapeutic Intervention on Backward Disequilibrium in Elderly Stroke Patients

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ABSTRACT

Backward disequilibrium is defined as posterior position of centre of mass with respect to the base of support. This abnormal posture is most commonly seen in elderly subjects and persons with any neurological disorder. Though it is most commonly seen in daily clinical practice, there is no epidemiological data for prevalence and management addressing this condition. Therefore, this study aimed to identify the effectiveness of specific therapeutic intervention for backward disequilibrium compared to conventional balance exercises in elderly stroke patients. In this study, a total number 30 elderly stroke patients, who fulfilled the inclusion and exclusion criteria were selected and allotted to either control or experimental groups. Later both groups were given separate set of exercises for the period of 2 weeks. Subjects were evaluated using the scale of retropulsion pre and post-test. Two sample t- test was used for within group analysis, while Independent t-test was used for between group analysis to find the statistical significance. Patients in the interventional group who underwent exercise programme specific to backward disequilibrium (anterior trunk tilt exercises) showed reduction in the overall symptoms, when compared to patients in control group who received conventional balance exercises. Hence this therapeutic intervention can be used for patients diagnosed with backward disequilibrium condition in future for effective reduction in the symptoms.

Keywords: Backward disequilibrium, posterior falls in elderly, physiotherapy, fall risk, fear of fall, Psychomotor Disadaptation syndrome.





INTRODUCTION

Backward disequilibrium is defined as posterior position of centre of mass with respect to the base of support. It is also known as a postural disorder where there is distortion in the perception of the postural vertical.(1) It is characterized by backward trunk tilt where the body is pushed posterior vertical orientation, causing difficulty in changing body from one position to another or while doing any other functional activity. This results in frequent backward fall of the individual and inability to shift the centre of gravity forward. This postural behaviour is most commonly caused by neurological conditions in central nervous system lesions such as ischemic/ haemorrhagic stroke, cortical and subcortical lesions, Parkinson, peripheral nervous system lesions and other various neurological and psychological conditions. Moreover, authors have examined this type of postural disorder in elderly subjects (2) and they conclude that cortical and subcortical lesions of central nervous system are the main factors leading to the development of backward disequilibrium. Among other conditions, stroke stands as a major cause for various balance and abnormal postural behaviour including Backward Disequilibrium. Stroke is the secondary leading cause of death worldwide and third most common cause leading to disability (3). Overall, in 2010 estimated number of 16.9 million stroke case happened worldwide. Backward disequilibrium has been related to the pushing behaviour in the frontal plane that's is observed in some patients diagnosed with hemiplegia (2,4).

This abnormal posture control is most commonly seen in elderly subjects with any neurological disorder. However, various studies state that subjective vertical orientation denotes the individual perception to the posture (5) consisting of 3 components related to visual vertical, tactile vertical and postural vertical. Backward disequilibrium is also known to be a component of Psychomotor in adaptation syndrome seen in geriatric population. In very elderly patients, various physical disabilities has been identified as being widely associated with postural instability, gait and balance abnormality. Backward Disequilibrium is more commonly seen in stroke, among them increasingly seen in elderly patients. Psychomotor disadaptation syndrome, which was initially described by Gaudet and colleagues in 1986, is characterised by postural impairments such as Backward disequilibrium, various neurological signs and psychological symptoms. As Backward disequilibrium causes frequent fall in elderly adults, it makes them highly vulnerable to physical trauma and high risk of acquiring post- traumatic syndrome resulting in difficulty in doing their activity of daily living at ease(6). Though it is most commonly seen in daily clinical practice there is no epidemiological data, prevalence and management addressing this condition and the pathophysiological mechanisms leading to this behaviour have not been clearly identified yet. Given the significance of this postural behaviour in our clinical practice it is not commonly addressed in evaluation nor treated as an important factor. The autonomy and functional ability of the older age adults could be improved by early diagnosis and management using physiotherapy intervention. Previous research papers available suggest that physiotherapy plays a major role in management of this postural abnormality and the therapy must be started as early as possible for effective management of the symptoms(2). Leaving this disorder untreated causes loss of self confidence in the elderly adults resulting in fear of walking, reduced level of independence and reduced Quality of living(9).

The primary treatment given for the patient suffering from Backward disequilibrium are the conventional balance exercises which was used to treat all the balance related issues in common along with other strengthening exercises, but this disorder has to be treated separately according to the symptoms. An interventional study done by Patricia L. Scheets et al.2015 to identify the effect of exercise program for an elderly patient at the age of 83 was identified as a sample due to the history of frequent fall during the treatment period the patient received 44 visits over a period of 14 weeks and evaluated pre and post the treatment identified the patient improved from needing 2 assistances to 1 assistance for fulfilling her daily living activities. Therefore, through this study, we are going to find the effectiveness of a therapeutic intervention specific to Backward Disequilibrium which improves trunk control by promoting forward trunk tilt. This will help in reducing the symptoms of backward disequilibrium in relation to conventional balance exercise in elderly stroke patients, preventing falls and improves quality of life.





METHODOLOGY

A total number of 30 elderly stroke patients who fulfilled the inclusion (patients with the age of 65 and above, patients with post-stroke, patients who scored 8 and above in the scale, patients who are medically stable) and exclusion criteria (Patients with vestibular disorder and visual disturbance, Patients with musculoskeletal and other neurological disorders, Patients who couldn't sit even while giving maximal support) were recruited for the study from Sri Ramachandra Medical centre and Hospital. Informed consent was obtained after explaining the study procedures, then baseline characteristics such as name, age, gender, history were collected. Later the patients were evaluated using the scale – Scale of Retropulsion. This scale consist of four subtests such as Static, Reactive, Resistance, and Dynamic postural control which is evaluated in both sitting and standing position. Then the patients were allotted to either a control or interventional group by random sampling. Later both groups were taught with separate set of exercises (as mentioned below) and monitored for the duration of two weeks and again evaluated using the scale of retropulsion.

Exercises for control group

1. Side walking

The patient is made to stand facing the therapist holding both the hand of the patient for support and a person over the side if assistance is required. Then the patient is asked to walk sideways by placing one foot laterally followed by other.

2. Same place marching

The patient is asked to hold a therapist hand or any sturdy object and made to lift his both legs alternatively and asked to repeat the same.

3. Side to side weight shifting

Similarly, the patient is asked to hold the therapist hand or any object and instructed to put his/her body weight over one limb at a time followed by shifting the weight to other limb thereby repeating the steps.

4. Perturbation

It is done in either sitting or standing depending upon the patient condition. Here the patient the made to either sit/stand instructing the patient that I am going to push you mildly towards any direction and he/she have to hold up to his neutral position as much as possible.

Exercises for Interventional group

1. Sitting to standing

Chair is placed against the wall for maximum stability made the patient to sit in chair and hold the therapist hand for support and do sit to stand without leaning the trunk backward. Can reduce the support of the therapist after few sessions and promote independent movements and can progress by increasing the depth of the sitting surface

2. Standing with the back against the wall with the heels touching the wall

Make the patient to stand against the wall with the heels against the wall can provide assistive support if needed later progressively reduce the support of hand but foot position should be maintained and gradually increase the duration without showing the signs of any resistance. Progression is made by introducing upper extremity movements without showing any form of resistance.

3. Forward reaching activities

This is done in either sitting /standing depending upon the patient stability then produce active sway forward making the centre of mass to move forward. Later can improved by making the patient to lean forward for reaching objects and repeating the steps.

4. Continuous stepping

Making the patient to continuously walk forward without any pause and maintaining the forward progression of centre of mass throughout the course. Therapist is assisting the patient for safety. Each exercise was given for the



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duration of 45 mins for 5 days per week with 2×10 repetition each with the rest period of 5 min between each step.

RESULTS AND DISCUSSION

In this study, a total number of 30 patients were recruited which there were 9 males and 6 females in the Interventional group and 8 males, and 7 females in the Control group. Patients were assessed in both sitting and standing positions using the Scale of Retropulsion Pre and Post-duration of intervention. The exercise program given to the interventional group mainly focuses on improving trunk control by promoting vertical tilt of the trunk which in return reduces the posterior falls. The result obtained after the statistical analysis of both the Interventional and Control groups showed that the Interventional group showed a reduction in score which is significant than the patients in the Control group. In the Interventional group the patients showed a reduction in the symptoms in sitting position compared to standing position.

In static postural control in the interventional group shows significant improvement than the control group. Among all other subtests, static control showed great improvement in the symptoms. The study shows that static balance control is improving in the patients receiving functional-based activities therefore the training program specific to the condition would have a significant improvement in improving the static balance control in both sitting and standing positions(18).

In reactive postural control component, in a standing position patients in the interventional group showed significant improvement than in control group. Which thereby improved the fear of falls in the patients. The endurance training has a minimum improvement in reactive control, therefore the exercise program in this study will give a great improvement in improving balance(19).

In resistance control, sitting position shows good improvement than in standing position in control group. In interventional group, there was a significant improvement in both sitting and standing position. In resistance control, which is the ability of the patient to withstand the resistance of the trunk passive movements for within-group analysis showed a significance p value <0.05* in sitting. In standing positions, the significance level showed a minimum significance value(20).

In dynamic postural control when compared with all other components, this has less improvement in the symptoms. In a study they compared for the improvement of balance post stroke for patient with physical therapy versus no treatment and the result showed that there is overall improvement in balance in patients who were given physiotherapeutic management compared with patients with no treatment with mean difference 0.46 with moderate quality of evidence(8). Overall, we can see that Static and Reactive postural control showed much improvement than Resistance and Dynamic postural control in both Interventional and Control groups. Therefore, the therapeutic interventional training specifically for the condition Backward Disequilibrium is a safe and well-accepted effective intervention for elderly population that could become a successful intervention for falls prevention in elderly in the near future.

CONCLUSION

The findings of this study demonstrate the potential benefits of the therapeutic intervention specific to the condition in correcting the disorders in posterior postural verticality, reducing symptoms of Backward Disequilibrium. The patients in Interventional group have shown overall significant improvement in achieving their goals, reduction in assistance, and reduced fear of fall, when compared with the patients in the control group who received conventional balance exercises. Knowledge of this postural behaviour associated with physical examination may





assist the Physiotherapist in identifying this clinical condition and providing a specific interventional program for effective reduction in the symptoms. This could become a successful interventional program for elderly patients with Backward Disequilibrium in the near future.

SCOPE FOR FUTURE STUDIES

More studies can be done in future on Backward disequilibrium occurring in other neurological conditions.

CONFLICT OF INTEREST

There is no conflict of interest between the authors during the course of the study.

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Table 1 : Between group analysis for subtests of scale of retropulsion

Subtests	Testing position: Sitting/standing	Control post Mean (SD)	Intervention post Mean (SD)	P value
Static	Sitting	0.87(0.35)	0.47(0.51)	<0.001
	Standing	0.93(0.25)	0.33(0.67)	<0.001
Reactive	Sitting	1.27(0.45)	0.80(0.67)	<0.001
	Standing	1.53(0.51)	0.80(0.67)	<0.001
Resistance	Sitting	2.00(0.00)	1.47(0.74)	<0.001
	Standing	2.13(0.51)	1.67(0.72)	<0.001
Dynamic	Sitting	2.60(0.50)	2.00(0.53)	0.002
	Standing	2.87(0.35)	2.53(0.51)	0.42

*All the subcomponents showing significance level of improvement, but dynamic component is showing less significance level.

Table 2: Within group analysis for Interventional and Control group.

Subtests	Testing position: Sitting/ Standing	Control Group			Interventional Group		
		Pre-mean (SD)	Post-mean (SD)	p value	Pre-mean (SD)	Post-mean(SD)	p value
Static	Sitting	1.87(0.36)	0.87(0.35)	0.019	1.53(0.63)	0.47(0.51)	<0.001
	Standing	1.93(0.26)	0.93(0.25)	<0.001	1.27(0.57)	0.33(0.67)	0.004
Reactive	Sitting	1.93(0.26)	1.27(0.45)	0.018	1.93(0.26)	0.80(0.67)	0.001
	Standing	2.53(0.52)	1.53(0.51)	0.002	1.86(0.64)	0.80(0.67)	0.004
Resistance	Sitting	2.40(0.51)	2.00(0.00)	0.001	2.07(0.70)	1.47(0.74)	<0.001
	Standing	2.86(0.35)	2.13(0.51)	0.052	2.42(0.51)	1.67(0.72)	0.019
Dynamic	Sitting	2.73(0.46)	2.60(0.50)	0.004	2.53(0.52)	2.00(0.53)	0.002
	Standing	3.00(0.00)	2.87(0.35)	0.48	3.00(0.26)	2.53(0.51)	<0.001

*Resistance and Dynamic standing components showed less significant improvement than other components.





A Retrospective Study on Identification, Evaluation of Antimicrobial Resistance in Sepsis

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ABSTRACT

Rational use of antibiotics play a vital role in eradicating antibiotic resistance. However in case sepsis broad spectrum antibiotics should be administered as a part of empirical therapy to potentiate treatment efficacy. Our primary objective is to identify and evaluate antimicrobial resistance in sepsis based on culture Sensitivity and prescribing pattern of antibiotic in sepsis. A Retrospective observational study was conducted in tertiary care mallige hospital and subjects who were diagnosed with sepsis were selected in our study. Data was collected from the hospital's department of medical records. During the study interval, a total of 175 patients were diagnosed with sepsis, comprising 98 males and 77 females. Out of these, 125 patients were included in the study based on the inclusion criteria. In the age group of 50-70 years we have identified more number of patients suffering from sepsis with 68 patients, followed by the 30-50 year age range, with 32 patients. Inferior levels of evidence compared with prospective studies, our study was conducted in single site hence less number of subject identified. The culture sensitivity test results from patients played a crucial role in determining the suitability of empirical antibiotic treatment, with the ultimate goal of reducing mortality and morbidity in sepsis patients. Notably, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* were the most frequently isolated organisms detected in patients with sepsis.

Keywords: Sepsis, Culture sensitivity, Antimicrobial resistance, Procalcitonin, Mortality rate.





INTRODUCTION

Sepsis is a severe inflammatory disease occur by infection, which leads to a global health care problem.[1]Sepsis is a condition characterized by physiological, biological, and biochemical abnormalities, resulting from an uncontrolled inflammatory response to infection.[2]Sepsis is a main cause of mortality in In-patient department with a mortality rate of 20 to 54%[3].Annually, around 49 million individuals are impacted by sepsis. 11 million deaths attributed to the syndrome, resulting to 19.7% of global mortality.[4] Various risk factors, co-morbidities and different severity of sepsis leads to higher death rate.[5,6,7] Around the globe some countries show death rate of 50% and some other countries show a death rate as low as 20-30% from septic shock.[8] In severe sepsis patients develop septic shock primarily and progress to organ failure with decreased blood pressure.[9]Sepsis exerts a broad impact on various aspects of the body, encompassing endothelial tissues and microcirculation. This leads to a large amount of neurological damage which in turn affect the neurons and neurological cells.[10,11]Organisms that increases the severity of sepsis are *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Escherichia coli* . Inflammatory responses are stimulated in the blood stream by bacteria and their by-products. The eradication of the sepsis-causing pathogen necessitates empirical antibiotic use, which should also encompass an assessment of the infection site [11] In most of the pateints irrational overuse of antimicrobial therapy lead to increased mortality rate. Therefore, we sought to analyze antibiotic prescribing patterns in sepsis and irrational use of broad spectrum antibiotics. [12]

MATERIALS AND METHODS

From January to July 2022, a retrospective investigation was conducted at Mallige Hospital in Bangalore. The study focused on patients aged between 30 and 79 years, who were characterised into sepsis, severe sepsis, septic shock during their hospital stay from february 2nd to December 29th, 2021. Met the criteria for inclusion in the study. Maternal and neonatal sepsis cases were not included from the study. Data was collected from the hospital's department of medical records, encompassing patient age, gender, admission and discharge dates, unique patient IDs, diagnoses, risk factors, site of infection, report of microbial culture sensitivity tests, antimicrobial prescription patterns, duration of stay, and prognosis. The pattern of antibiotic resistance was acquired from the reports of Anti-microbial cultures and antibiotic sensitivity testing conducted during hospitalization. Various medical documents were used to document the antibiotic use during patients stay in hospital. The identification of microbes from the microbial reports was based on clinical decisions, taking into account the source of infection. The CLSI Standard was followed in determining the types of antibiotics and sensitivity levels in the susceptibility test.[9] Data collection forms were utilized to account demographic details, diagnosis, and the antibiotics administered to patients. The succeeding information was noted from medical documents: age, gender, the source of infection, sepsis severity, the duration of hospital stay, co-morbidities, antibiotics used, culture sensitivity, and procalcitonin levels. The collected data were then summarized for analysis.

RESULTS

Characteristics of the Subject Population

During the study interval, a total of 175 patients were diagnosed with sepsis, comprising 98 males and 77 females. Out of these, 125 patients were included in the study based on the inclusion createria. In the age group of 50-70 years we have identified more number of pateints suffering from sepsis with 68 patients, followed by the 30-50 year age range, with 32 patients. The death rate was 24% in both males and females, but the incidence rate was higher in females. When comparing the death rate between genders in the > 50 years age group, the study revealed a higher mortality rate in males (60%) than in females (40%). However, in the 18-50 year age group, the mortality rate in females (60%) was higher than in males (40%). Among the subject population, 48 individuals (38.4%) did not achieve a complete recovery and were discharged on medical advice. The most common co-morbidities in the subject



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population were diabetes mellitus (24.84%), hypertension (22.95%), respiratory diseases (11%), renal dysfunction (9.11%), pneumonia (6.28%), and heart failure (3.77%). Covid infection led to more number of deaths. Resulting in death of 6 patients due to respiratory disorders. Mortality resulting from urinary tract infection, heart failure, hepatic dysfunction, and hepatic failure was followed by this. A detailed breakdown of the subject population's characteristics, including age, gender, and co-morbidities, is provided in Table 1.

The Antimicrobial Susceptibility Test

A total of 419 susceptibility tests were conducted on 31 antibiotics (n = 419). Among them, 13 antibiotics exhibited a resistance level of $\geq 50\%$, while 18 antibiotics were resistant upto $\geq 50\%$. However, not all antibiotics underwent sensitivity testing. Notably, Ampicillin, Cefoxitin, and Ceftazidime demonstrated 100% resistance to sepsis-causing microbes. In contrast, the following antibiotics showed considerable efficacy in treating various types of sepsis: Meropenem, Imipenem, Ertapenem, Piperacillin with tazobactam, Cefoperazone and sulbactam, Linezolid, Daptomycin, Colistin, Polymyxin B, Minocycline, Nitrofurantoin, Amphotericin B, Caspofungin, Micafungin, Fluconazole, and Voriconazole, all displaying an efficacy rate of $>70\%$. For a comprehensive overview of an antibiotic sensitivity and resistance patterns, please refer to Table 2

In the context of susceptibility testing, the table notation is as follows:

N: Number of susceptibility tests conducted,

S: Sensitive results,

I: Intermediate results,

R: Resistant results,

Efficacy (%) = $(S + I) / N \times 100\%$, and

Resistance (%) = $R / N \times 100\%$ [9].

The Pattern of Source of Sepsis Infection

Six distinct sources of infection were identified, all of which progressed to sepsis. Lung infection (48%), Urinary tract infection (26.4%), Chronic kidney disease (11.2%), Hepatic disease (7%), Skin and soft tissue (4.4%), and Encephalopathy (3%).

The Pattern of Microbial Culture

In total 125 microbial cultures (n = 125) were performed on our sample population, with 56% yielding positive results and 44% negative results. Among these cultures, 11 different organisms were identified from various specimens. The organisms detected by microbial culture included: *Streptococcus viridus*, *Streptococcus pneumoniae*, *Stenotrophomonas maltophilia*, *Citrobacter freundii*, *Streptococcus pyogenes*, Gram-positive cocci, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Staphylococcus epidermis*, *Klebsiella pneumonia*, *Escherichia coli*, were the microbes detected in the microbial. The pattern of these organisms isolated from the culture sensitivity test is detailed in Table 2.

Antibiotic Prescribing Pattern

In sepsis, the subject population received a total of 31 different antibiotics. These antibiotics belonged to various classes, including carbapenems, beta-lactams, aminoglycosides, quinolones, macrolides, antifungals, tetracycline, semisynthetic glycopeptides, sulfonamides, nitroimidazole, oxazolidinones, antiviral drugs, and others. The pattern of antibiotic usage is visually presented in Figure 2.

Procalcitonin Levels in Sepsis

Procalcitonin, the prohormone of calcitonin, is secreted at significantly elevated levels, often thousands of times higher than the normal range. Research has indicated a correlation between serum Procalcitonin values and the severity of sepsis. Procalcitonin is a remarkable biomarker to accommodate in the diagnosis of sepsis, as well as related infectious. [13] While it is surprising, serum procalcitonin values may decrease to lower levels during severe infections when appropriate antimicrobial therapy is administered. [14] Out of 125 sepsis patients in the study, 34.5%



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of patients was having a procalcitonin level of 0.5 – 2ng/ml, 31.9% of patients having 2-10ng/ml, 26.1% patients having <0.5ng/ml of procalcitonin level.

DISCUSSION

The Subject Population's Characteristics

In this study, sepsis was observed to be more prevalent among patients over the age of 50. Surprisingly, despite the higher incidence in 18-50 year age range, the death rate was higher in this group, with 15 out of 44 patients succumbing to the condition. Similarly, in the age group above 50, there were 81 patients, of which 15 patients died. Notably, the mortality of sepsis increases significantly above the age of 60, especially when proper empirical antibiotic therapy is not initiated. [15]. Understanding the relationship between age and mortality requires controlling for factors that may influence the outcome. [11] Regarding gender distribution, the current study included slightly more female patients than male patients. However, the recovery rate among males was found to be higher compared to females in our analysis. Achieving a balance between preventing infections and managing antibiotic prescriptions rationally to avoid antibiotic resistance largely depends on implementing appropriate empirical antibiotic treatment and considering the overall benefit. [16]. Our study findings highlight that co-morbidities contribute to an elevated mortality rate in elderly patients compared to younger ones. Additionally, another study demonstrated that improper use of broad empiric therapy was linked to increased mortality. [12]

The Pattern of a Source of Site of Infection

The variables that contribute in death rate of patients can alter the source of sepsis, potentially explaining the challenge in devising a precise treatment algorithm for effectively managing sepsis and reducing mortality rates. [17] In this study, lungs emerged as the most frequently identified source of infection leading to sepsis. Sepsis commonly arises from pulmonary and gastrointestinal infections, and the source of infection-associated mortality accounts for nearly 60% of cases. [18] Among lung infection, the common disease that contributed to the origin of infection was hospital-acquired pneumonia and CAP [19]. Studies showed that intravascular devices and mechanical ventilators were the main origin of infection [20]. In our study duration, there were least cases with intravascular devices and mechanical ventilators as origin of infection which is one of the limitations of the study.

The Patterns of Prescribing Antibiotic and Sensitivity

Among hospital antibiotic drug formulary, 31 antibiotics were allocated to the subject population in sepsis. Among them, Meropenem, Cefoperazone with sulbactam, Piperacillin with tazobactam, Clindamycin, Ceftriaxone, Clarithromycin, and Metronidazole were the most frequently used antibiotics. Out of these 31 antibiotics, 13 exhibited resistance above 50% based on microbial culture sensitivity reports and antibiotic prescribing pattern. Approximately 41.93% of the antibiotics displayed resistance levels above 50%. On the other hand, a sum of 18 antibiotics demonstrated resistance levels below 50%, including Amikacin, Cefoperazone with sulbactam, Ertapenem, Imipenem, Meropenem, Piperacillin with tazobactam, Amoxicillin with clavulanic acid, Nitrofurantoin, Amphotericin B, Caspofungin, Micafungin, Fluconazole, Voriconazole, Tetracycline, Linezolid, Daptomycin, Colistin, Polymyxin B, and Minocycline. In this study, empirical antibiotics were selected based on the resistance level falling below 50%. Additionally, consideration was given to other factors such as the source of infection, patient characteristics, and other patient-specific factors when choosing the appropriate antibiotics. A graphical representation of the administered antibiotics can be seen in Figure 2. Sepsis detection is reportedly proportional to decreased mortality rate, hospitals should have an early recognition and management of sepsis. [1,2,6,21] Administering antibiotics within the initial hour of identifying the severity of sepsis led to recovery rates of up to 80%. Appropriate antibiotic therapy is characterized by giving at least one broad spectrum antibiotic [22]. Initial empiric antibiotic therapy must be effective against a broad spectrum of microbes. Maximum The recommended antibiotic doses should be administered intravenously for a duration of 7 to 10 days, with the possibility of updating the treatment based on individual culture sensitivity test results. [9,6] International guidelines strongly recommend that appropriate antimicrobial therapy be provided within one hour of identifying cases of sepsis. [15] The updated



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evidence in accordance with the 2016 guidelines prompted the implementation of the "Hour-1-Bundle." This bundle consists of five clinical interventions. Antimicrobial resistance has emerged as a significant challenge. Antibiotic resistance can arise from intrinsic characteristics or genetic alterations in the bacteria, leading to decreased effectiveness. Notably, one of the primary antibiotic resistance mechanisms in many bacterial species is the production of beta-lactamases against beta-lactam antibiotics. [6]. The most frequently used antibiotics in critical care settings are b-Lactams and carbapenems.[23] In summary, various studies have reported different correlations between co-morbidities and recovery rates. In our study, patients with multiple co-morbid conditions exhibited lower recovery rates. Additionally, our retrospective analysis indicated a high resistance rate in initial empirical therapy, emphasizing the critical importance of selecting the appropriate empirical antibiotic treatment to reduce mortality and hospital stay duration. To enhance the efficacy of subsequent antibiotic treatment, it is crucial to base antibiotic selection on the results of culture sensitivity tests. Thus, the culture sensitivity test plays a vital role in refining the spectrum of antibiotic treatment and significantly influences treatment outcomes.

CONCLUSION

To address the escalated resistance levels observed in antibiotics like cefoxitin, ceftazidime, ampicillin, cefepime, and ciprofloxacin, guidelines are crucial for controlling their usage. The culture sensitivity test results from patients played a crucial role in determining the suitability of empirical antibiotic treatment, with the ultimate goal of reducing mortality and morbidity in sepsis patients. Notably, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* were the most frequently isolated organisms detected in patients with sepsis. Additionally, lung infections and urinary tract infections were found to be the most frequent sources of infection in patients with sepsis.

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Table 1 The Subject Population's Characteristics. (n=125)					
CHARACTERISTICS	OUTCOMES			UNKNOWN[%]	TOTAL[%]
	RECOVERED[%]	DIED [%]	NOT RECOVERED [%]		
Gender					
Male	30 [55.55]	10 [18.86]	13 [24.07]	0 [0]	53 [43.2]
Female	15 [21.12]	20 [28.57]	35 [49.29]	0 [0]	70 [56.8]
Age					
18-50	18 [40.90]	15 [34.09]	11 [25]	0 [0]	44 [35.2]
>50	30 [37.03]	15 [18.51]	36 [44.44]	0 [0]	81 [64.8]
Comorbidities					
Diabetes mellitus	14 [17.72]	50 [63.29]	15 [18.98]	0 [0]	79 [24.84]
Hypertension	6 [8.21]	61 [83.56]	6 [8.21]	0 [0]	73 [22.95]





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Respiratory disease	2 [5.71]	30 [85.71]	3 [8.57]	0 [0]	35 [11]
Renal dysfunction	0 [0]	27 [93.10]	2 [6.89]	0 [0]	29 [9.11]
Pneumonia	0 [0]	19 [95]	1 [5]	0 [0]	20 [6.28]
Heart failure	1 [8.33]	10 [83.33]	1 [8.33]	0 [0]	12 [3.77]
Renal failure	0 [0]	9 [90]	1 [10]	0 [0]	10 [3.14]
Thyroid disease	4 [40]	6 [60]	0 [0]	0 [0]	10 [3.14]
Ischaemic heart disease	2 [20]	1 [70]	1 [10]	0 [0]	10 [3.14]
Encephalopathy	1 [12.5]	6 [75]	1 [12.5]	0 [0]	8 [2.51]
Dyslipidemia	2 [28.57]	5 [71.42]	0 [0]	0 [0]	7 [2.20]
Urinary tract infection	0 [0]	7 [100]	0 [0]	0 [0]	7 [2.20]
Covid infection	0 [0]	6 [100]	0 [0]	0 [0]	6 [1.88]
Hepatic failure	0 [0]	5 [100]	0 [0]	0 [0]	5 [1.57]
Hepatic dysfunction	1 [20]	4 [80]	0 [0]	0 [0]	5 [1.57]
Anemia	1 [50]	0 [0]	1 [50]	0 [0]	2 [0.62]

Table 2 The Extent Of Antibiotic Resistance Determined Through Susceptibility Testing In The Subject Population

ANTIBIOTIC	N	S	I	R	RESISTANCE [%]	EFFICAC [%]
Amikacin	22	15	-	7	31.81	68.19
Cefperazone and salbactam	23	19	-	4	17.39	82.61
Ertapenem	27	20	-	7	25.92	74.08
Imipenem	27	19	-	8	29.62	70.38
Meropenam	42	28	2	12	28.57	71.43
Piperazine and tazobactam	30	20	1	9	30	70
Amoxicillin/clavulanate	13	2	1	10	76.92	24.08
Cefepime	10	1	-	9	90	10
Ceftriaxone	10	-	2	8	80	20
Cefuroxime	8	-	1	7	87.5	12.5
Ciprofloxacin	10	-	1	9	90	10
Fosfomycin	5	1	1	3	60	40
Gentamicin	23	6	1	16	69.56	30.44
Co-trimoxazole	20	7	-	13	65	35
Astreonom	7	1	1	5	71.42	28.58
Nitrofurantoin	16	12	-	4	25	75
Amphotericin B	8	7	-	1	12.5	87.5
Caspafungin	8	6	-	2	25	75
Micafungin	8	4	2	2	25	75
Fluconazole	8	8	-	-	-	100
Voriconazole	8	6	1	1	12.5	87.5
Levofloxacin	15	7	-	8	53.33	46.67
Tetracyclin	14	12	1	1	7.14	92.86
Linezolid	16	15	1	-	-	100
Daptomycin	5	5	-	-	-	100
Colistin	16	13	1	1	6.25	93.75





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Ampicillin	5	-	-	5	100	-
Polymyxin B	7	6	1	-	-	100
Cefoxitin	2	-	-	2	100	-
Ceftazidime	2	-	-	2	100	-
Minocycline	4	2	2	-	-	100

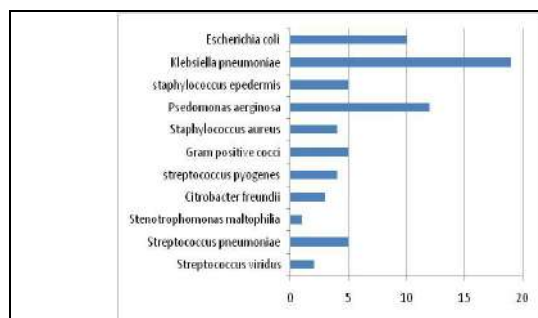


Figure 1 organisms isolated

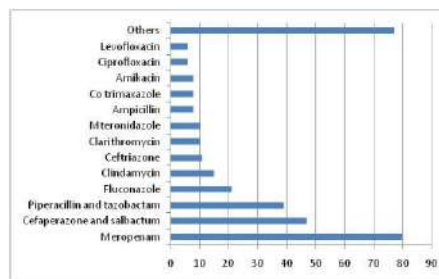


Figure 2 the antibiotic usage pattern at mallige hospital included a wide range of antibiotics, such as amoxicillin, cefuroxime, cefadroxil, cefotaxime, ceftazidime, cefepime, erythromycin, ampicillin-sulbactam, amoxicillin and clavulanic acid, linezolid, biapen

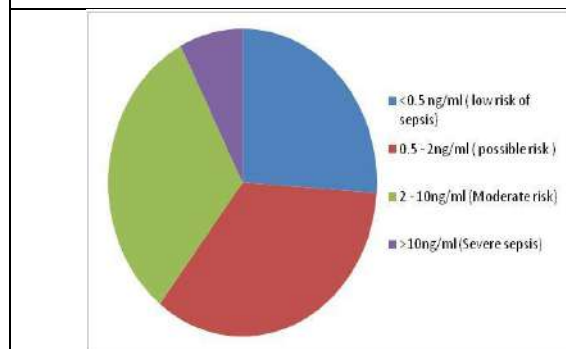


Figure 3 Procalcitonin levels and severity of sepsis

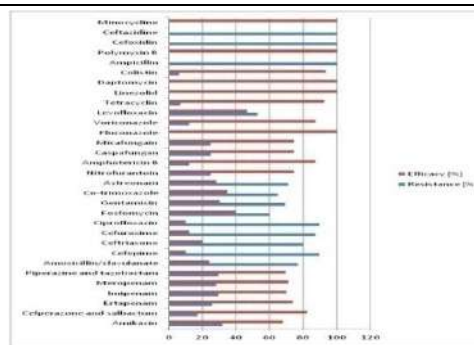


Figure 4 Pattern of antibiotic efficacy% and antibiotic resistance %





Periodic Recurrence Relation

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ABSTRACT

Recurrence Relations are useful in exploring several interesting properties. This paper explores into the concept of linear recurrence relations where the coefficients are modified suitably. The paper is focused upon solving a specific linear recurrence relation of the form $P(n+2) = \lambda_1 P(n+1) + \lambda_2 P(n)$, $n \geq 0$, $P(0) = 0$, $P(1) = 1$ and obtain solutions which are complex conjugates. Surprisingly, these complex valued solutions display periodic behavior. The paper then extends this analysis by generalizing one of the coefficients. In all the cases, the periodic nature of the solutions is preserved.

Keywords: Recurrence Relation, Binet's Formula, Periodic function, Period.

INTRODUCTION

Recurrence relations are mathematical equations used to define the relationship between terms in a sequence. They are widely used in various fields, such as computer science, physics, and economics to model and analyze dynamic systems. Recurrence relations are useful in solving problems which are recursively defined like Tower of Hanoi and Fibonacci sequence. Periodic recurrence relations are such a specific type of recurrence relations whose solutions forms periodic functions.

DEFINITION

We define a linear recurrence relation by

$P(n+2) = \lambda_1 P(n+1) + \lambda_2 P(n)$, $n \geq 0$, $P(0) = 0$, $P(1) = 1$, where λ_1 and λ_2 are any two real or complex numbers.





Theorem 1 If λ_1 and λ_2 are two real numbers such that

$$P(n+2) = \lambda_1 P(n+1) + \lambda_2 P(n), \quad n \geq 0, P(0) = 0, P(1) = 1 \quad (1)$$

then the general solution of the recurrence relation (1) is given by

$$P(n) = \frac{m_1^n - m_2^n}{m_1 - m_2} \quad (2)$$

Proof: The characteristic equation of recurrence relation (1) is given by $m^2 - \lambda_1 m - \lambda_2 = 0$

The solutions of above quadratic equation is $m = \frac{\lambda_1 \pm \sqrt{\lambda_1^2 + 4\lambda_2}}{2}$

$$\text{We consider } m_1 = \frac{\lambda_1 + \sqrt{\lambda_1^2 + 4\lambda_2}}{2} \text{ and } m_2 = \frac{\lambda_1 - \sqrt{\lambda_1^2 + 4\lambda_2}}{2} \quad (3)$$

The general solution is $P(n) = Am_1^n + Bm_2^n$

Since $P(0) = 0$, $A + B = 0$

We get $B = -A$ and from $P(1) = 1$, we have $1 = Am_1 + Bm_2$

$$\text{Hence, } A = \frac{1}{m_1 - m_2} \text{ and } B = \frac{-1}{m_1 - m_2}$$

Thus, $P(n) = \frac{m_1^n - m_2^n}{m_1 - m_2}$ proving (2).

Note that the expression for $P(n)$ given in (2) is known as Binet's formula

Theorem 2

If $P(n)$ is a recurrence relation such that $P(n+2) = \lambda_1 P(n+1) + \lambda_2 P(n)$, $n \geq 0$, $P(0) = 0$, $P(1) = 1$ with $\lambda_1 = -1$ and $\lambda_2 = -1$ then $P(n)$ is a periodic function with period 3α , $\alpha \in \mathbb{Z}$. That is, $P(n+3\alpha) = P(n)$ for all $\alpha \in \mathbb{Z}$.

Proof: From (2) of theorem 1, $P(n) = \frac{m_1^n - m_2^n}{m_1 - m_2}$

For $\lambda_1 = -1$ and $\lambda_2 = -1$ by (3), we get

$$m_1 = \frac{-1+i\sqrt{3}}{2} = \omega \text{ and } m_2 = \frac{-1-i\sqrt{3}}{2} = \omega^2 \quad (4)$$

We note that ω and ω^2 are complex conjugates and $\omega^3 = 1$

$$\text{Hence, } P(n) = \frac{\omega^n - \omega^{2n}}{\omega - \omega^2}$$

$$\begin{aligned} \text{Using above expression we get, } P(n+3\alpha) &= \frac{\omega^{n+3\alpha} - \omega^{2(n+3\alpha)}}{\omega - \omega^2} \\ &= \frac{\omega^n \omega^{3\alpha} - \omega^{2n} \omega^{6\alpha}}{\omega - \omega^2} \\ &= \frac{\omega^n - \omega^{2n}}{\omega - \omega^2} = P(n) \text{ since } \omega^3 = 1 \end{aligned}$$

Thus, $P(n+3\alpha) = P(n)$ for all $\alpha \in \mathbb{Z}$.

Theorem 3

If $P(n)$ is a recurrence relation such that $P(n+2) = \lambda_1 P(n+1) + \lambda_2 P(n)$, $n \geq 0$, $P(0) = 0$, $P(1) = 1$ with $\lambda_1 = 0$ and $\lambda_2 = -1$ then $P(n)$ is a periodic function with period 4α , $\alpha \in \mathbb{Z}$. That is, $P(n+4\alpha) = P(n)$ for all $\alpha \in \mathbb{Z}$.

Proof: From (2) of theorem 1, $P(n) = \frac{m_1^n - m_2^n}{m_1 - m_2}$

For $\lambda_1 = 0$ and $\lambda_2 = -1$ by (3), we get

$$m_1 = i \text{ and } m_2 = -i \quad (5)$$

We note that i and $-i$ are complex conjugates and $i^4 = 1$, $(-i)^4 = 1$

$$\text{Hence, } P(n) = \frac{(i)^n - (-i)^n}{(i) - (-i)} = \frac{(i)^n - (-i)^n}{2i}$$

$$\begin{aligned} \text{Using above expression we get, } P(n+4\alpha) &= \frac{(i)^{n+4\alpha} - (-i)^{n+4\alpha}}{2i} \\ &= \frac{i^n i^{4\alpha} - (-i)^n (-i)^{4\alpha}}{2i} \\ &= \frac{(i)^n - (-i)^n}{2i} = P(n) \end{aligned}$$

Therefore, $P(n+4\alpha) = P(n)$, for all $\alpha \in \mathbb{Z}$.





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Theorem 4

If $P(n)$ is a recurrence relation such that $P(n+2) = \lambda_1 P(n+1) + \lambda_2 P(n), n \geq 0, P(0) = 0, P(1) = 1$ with $\lambda_1 = 1$ and $\lambda_2 = -1$ then $P(n)$ is a periodic function with period $6\alpha, \alpha \in \mathbb{Z}$. That is, $P(n+6\alpha) = P(n)$ for all $\alpha \in \mathbb{Z}$.

Proof: From (2) of theorem 1, $P(n) = \frac{m_1^n - m_2^n}{m_1 - m_2}$

For $\lambda_1 = 1$ and $\lambda_2 = -1$ by (3), we get

$$m_1 = \frac{1+i\sqrt{3}}{2} = \zeta \text{ and } m_2 = \frac{1-i\sqrt{3}}{2} = \zeta^5 \quad (6)$$

We note that ζ and ζ^5 are complex conjugates and $\zeta^6 = 1$

$$\text{Hence, } P(n) = \frac{\zeta^n - \zeta^{5n}}{\zeta - \zeta^5} = \frac{\zeta^n - \zeta^{5n}}{i\sqrt{3}}$$

$$\begin{aligned} \text{Using above expression we get, } P(n+6\alpha) &= \frac{\zeta^{n+6\alpha} - \zeta^{5n+30\alpha}}{i\sqrt{3}} \\ &= \frac{\zeta^n \zeta^{6\alpha} - \zeta^{5n} \zeta^{30\alpha}}{i\sqrt{3}} \\ &= \frac{\zeta^n - \zeta^{5n}}{i\sqrt{3}} = P(n) \end{aligned}$$

Thus, $P(n+6\alpha) = P(n)$, for all $\alpha \in \mathbb{Z}$.

In the upcoming section, we prove a more general theorem

Theorem 5

If $P(n)$ is a recurrence relation such that $P(n+2) = \lambda_1 P(n+1) + \lambda_2 P(n), n \geq 0, P(0) = 0, P(1) = 1$ with $\lambda_1 = 2\cos\left(\frac{2\pi}{t}\right)$ and $\lambda_2 = -1$ then $P(n)$ is a periodic function with period $t\alpha, \alpha \in \mathbb{Z}$. That is, $P(n+t\alpha) = P(n)$ for all $t \geq 3$ and $\alpha \in \mathbb{Z}$.

Proof: The characteristic equation of given recurrence relation is $m^2 - \lambda_1 m - \lambda_2 = 0$

For $\lambda_1 = 2\cos\left(\frac{2\pi}{t}\right)$ and $\lambda_2 = -1$

We get $m^2 - 2\cos\left(\frac{2\pi}{t}\right)m + 1 = 0$

$$\left(m - e^{\frac{2\pi i}{t}}\right)\left(m - e^{-\frac{2\pi i}{t}}\right) = 0$$

Therefore, the solutions of characteristic equation of given recurrence relation are

$$m_1 = e^{\frac{2\pi i}{t}} = \cos\left(\frac{2\pi}{t}\right) + i \sin\left(\frac{2\pi}{t}\right)$$

$$m_2 = e^{-\frac{2\pi i}{t}} = \cos\left(\frac{2\pi}{t}\right) - i \sin\left(\frac{2\pi}{t}\right)$$

By Binet's formula, $P(n) = \frac{m_1^n - m_2^n}{m_1 - m_2}$

$$P(n) = \frac{\left(e^{\frac{2\pi i}{t}}\right)^n - \left(e^{-\frac{2\pi i}{t}}\right)^n}{e^{\frac{2\pi i}{t}} - e^{-\frac{2\pi i}{t}}} = \frac{2i \sin\left(\frac{2n\pi}{t}\right)}{2i \sin\left(\frac{2\pi}{t}\right)}$$

Note that $P(n)$ is not defined when $t = 1$ or $t = 2$

$$\text{Hence, } P(n) = \frac{\sin\left(\frac{2n\pi}{t}\right)}{\sin\left(\frac{2\pi}{t}\right)} \text{ for all } t \geq 3$$

$$\begin{aligned} \text{Consider } \alpha \in \mathbb{Z}, \text{ then } P(n+t\alpha) &= \frac{\sin\left(\frac{2(n+t\alpha)\pi}{t}\right)}{\sin\left(\frac{2\pi}{t}\right)} \\ &= \frac{\sin\left(\frac{2n\pi}{t} + 2\alpha\pi\right)}{\sin\left(\frac{2\pi}{t}\right)} = \frac{\sin\left(\frac{2n\pi}{t}\right)}{\sin\left(\frac{2\pi}{t}\right)} = P(n) \end{aligned}$$

Therefore, $P(n+t\alpha) = P(n)$ for all $t \geq 3$ and $\alpha \in \mathbb{Z}$.

Hence the recurrence relation $P(n)$ is periodic function with period $t\alpha, \alpha \in \mathbb{Z}$.





CONCLUSION

The results obtained in this paper reveals the periodic behavior of solutions of the linear recurrence relations when the coefficients are modified suitably. The emergence of complex and periodic solutions, even when the coefficients are generalized, highlights the beauty of the results obtained. In this paper, we have proved five theorems in which Binet's formula is proved in Theorem 1. Theorems 2, 3 and 4 are special cases of Theorem 5 when $t = 3, 4, 6$ respectively. The fact that the solutions to given recurrence relation being periodic function make this paper interesting. These results not only contribute to our understanding of periodic recurrence relations but also open up new avenues for future research, particularly in exploring the conditions under which such periodic behavior is preserved.

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The Influence of Artificial Intelligence (AI) on the Financial Services Landscape: A Digital Transformation

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ABSTRACT

The financial services sector is currently undergoing a significant transition due to the extensive adoption of Artificial Intelligence (AI) technologies. This study examines the significant influence of artificial intelligence (AI) on the financial industry, conducting an analysis of its diverse uses and resulting consequences. This study explores the ways in which artificial intelligence (AI) is transforming fundamental operations within financial institutions, including but not limited to risk assessment, algorithmic trading, and customer support. This study utilizes quantitative data analysis techniques and utilizes datasets from several financial institutions to offer empirical evidence regarding the effectiveness of artificial intelligence (AI) in areas such as risk assessment, trading, customer service, and other related domains. In addition, the study examine into the complexities presented by the integration of artificial intelligence (AI), encompassing ethical implications and adherence to legal frameworks. This research provides significant insights for stakeholders in the financial industry, policymakers, and researchers who are interested in understanding and adapting to the changing dynamics of AI-driven finance. Through the analysis of future trends and provision of crucial suggestions, this study is a helpful resource for navigating this growing landscape.

Keywords: Artificial Intelligence, Financial Services, Digital Disruption, Quantitative, Risk assessment, Customer service, trading.





INTRODUCTION

The financial services ecosystem, a pillar of modern economies, has historically been characterized by stability, trustworthiness, and custom. In recent years, however, a profound shift has occurred due to the relentless advancement of technology. This transition, commonly referred to as "digital disruption," has led in a new era in the financial sector, profoundly altering the landscape(Barroso & Laborda, 2022; Kiyotaka Sasaki, 2022; Luigi *et al.*, 2020). The financial services ecosystem consists of numerous institutions and activities, ranging from conventional banks and insurance companies to investment firms, payment processors, and fintech ventures(Soni, 2021). It is the lifeblood of economic development, allowing for the allocation of capital, the management of risk, and the facilitation of global transactions. Its significance cannot be overstated, as it supports global economic development and stability(Umamaheswari *et al.*, 2023). This study aims to conduct a comprehensive analysis of the impact of AI on the ecosystem of financial services in the context of digital disruption. We intend to investigate the multifaceted ways in which AI is not merely an instrument, but rather a driving force behind the ongoing financial revolution. This study aims to provide a comprehensive comprehension of how AI is reshaping the core operations of financial institutions and the consequences of this transformation. It is crucial for various stakeholders to comprehend the function of AI in the digital disruption of finance(Dube *et al.*, 2023; Kenji, 2016; A. Kumar, 2023). To remain competitive, financial institutions, from traditional banks to fintech firms, must comprehend how AI can enhance their operations, improve risk management, and introduce new services(Danielsson *et al.*, 2022). Researchers and industry analysts require insight to monitor trends and make accurate forecasts(Mhlanga, 2020; Raja Santhi & Muthuswamy, 2023).

As it embarks on this expedition through the AI-transformed financial services ecosystem, it becomes clear that AI-driven finance knowledge and adaptability are not merely advantageous, but essential(Gupta & Agrawal, 2021; Maple *et al.*, n.d.; Wach *et al.*, 2023). This transformation has far-reaching consequences, affecting not only the profitability of financial institutions but also the financial well-being of individuals and the economy as a whole. In addition, the study examines how AI is reshaping risk assessment, algorithmic trading, customer support, and other essential aspects of finance, providing empirical evidence of its efficacy and discussing the ethical and regulatory challenges it poses(Bisht *et al.*, 2022; Poola & Systems, 2023). Through this investigation, the study aims to provide stakeholders, policymakers, and researchers with valuable insights for navigating this era of unprecedented change.

LITERATURE REVIEW

Integration of Artificial Intelligence (AI) into the financial industry has been the topic of extensive research and analysis. Literature in this field is proliferating, highlighting the transformative potential of AI technologies to redefine financial services. Research studies have explored AI's impact across various dimensions, including risk management, investment strategies, customer service, and regulatory conformance(Asif *et al.*, 2023; Danielsson *et al.*, 2022; Dwivedi *et al.*, 2023; Gupta & Agrawal, 2021; Kiyotaka Sasaki, 2022; Plekhanov *et al.*, 2022; Rodgers *et al.*, 2023; Sampat *et al.*, 2023). To comprehend the contemporary impact of AI on finance, it is necessary to trace the evolution of AI technologies in the financial sector over time. The origins of AI in finance can be traced back to the 1980s, when credit scoring and portfolio optimization were performed by early AI systems(Maple *et al.*, n.d.; Poola & Systems, 2023). AI technologies, particularly deep learning and natural language processing, experienced exponential growth and began to transform financial services only in the last decade(Soni, 2021). Successful applications in other domains, such as image recognition and language translation, which demonstrated the adaptability and scalability of AI algorithms, accelerated the finance industry's incorporation of AI(Danielsson *et al.*, 2022; Plekhanov *et al.*, 2022). Literature on this historical progression emphasizes the incremental but transformative nature of AI's financial integration(Rodgers *et al.*, 2023). From rule-based expert systems to today's neural networks, AI technologies have undergone a remarkable transformation, transforming from niche applications to integral components of the operations of financial institutions(Barroso & Laborda, 2022). This study situates itself within the larger narrative of technological change in the financial sector by analyzing the historical context and development of AI technologies in



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finance. It endeavors to build upon the foundation established by previous research while providing new insights into the current impact and future prospects of AI-driven digital disruption in finance (Kiyotaka Sasaki, 2022; Sampat *et al.*, 2023). The study demonstrated how AI-powered algorithms have substantially enhanced risk assessment models in financial institutions. These developments have resulted in more accurate credit scoring, fraud detection, and a decline in default rates, ultimately augmenting the financial system's stability (Alsmadi *et al.*, 2023; Dube *et al.*, 2023). In addition, the influence of AI on algorithmic trading has been the subject of extensive research. A study have recently investigated the complexities of AI-driven trading strategies. They demonstrate how machine learning algorithms can process massive datasets and discern market trends at speeds unachievable by human traders, thereby ushering in a new era of high-frequency trading (Aldboush & Ferdous, 2023; Fares *et al.*, 2022; Kenji, 2016).

The ethical implications of AI's penetration into the financial sector have received considerable scholarly attention. It is investigated that the ethical challenges posed by AI, including algorithmic bias, data privacy, and the obligation of financial institutions to ensure fair and transparent AI-driven decision-making processes (Dwivedi *et al.*, 2023). This literature emphasizes the significance of aligning the development of artificial intelligence with ethical principles and regulatory frameworks. The regulatory environment encircling AI in finance is dynamic and incredibly complex. Researchers such as Bisht *et al.*, (2022); N. Kumar & Singh, (2020); Rodgers *et al.*, (2023) have examined the activities of regulatory bodies such as the Financial Stability Board and few Central Banks. Their studies evaluate the current state of artificial intelligence (AI) regulation, discuss the difficulties encountered by regulators, and propose strategies for fostering innovation while maintaining financial stability and consumer protection. In addition, more research is required on the ethical and legal implications of AI in finance, as well as the potential for AI to exacerbate existing inequalities (Bankins & Formosa, 2023; Dwivedi *et al.*, 2023; Maple *et al.*, n.d.; Rodgers *et al.*, 2023). Examining AI's impact on risk assessment, algorithmic trading, customer support, and other aspects of finance will contribute to filling these knowledge gaps, the study's authors say. This study seeks to provide empirical evidence and insights into the evolving landscape of AI-driven finance, while recognizing the ethical and regulatory factors that influence this transformation.

RESEARCH METHODOLOGY

Our research employs a mixed-methods strategy, incorporating both quantitative data analysis and qualitative insights. This method permits triangulation of findings and a comprehensive comprehension of AI's impact on the ecosystem of financial services (Chinnasamy *et al.*, 2021; Dhanya & Jayanthi, 2023). We gathered information from a variety of sources to assure the validity of our analysis. To gain access to the anonymized data of a variety of financial institutions, including banks, investment firms, and fintech companies, the primary data sources have been gathered from a selection of financial institutions. This information includes transaction records, consumer interactions, and financial performance from the past. In addition, surveys and interviews were conducted with key financial industry stakeholders, including CEOs, CIOs, risk managers, and AI practitioners. The study employed a variety of statistical techniques, including descriptive statistics, regression analysis, and time series analysis, to analyze the quantitative data. The study selected a variety of financial institutions, including large traditional banks, boutique investment firms, and innovative fintech businesses located in the state of Karnataka covering major four cities, in order to represent a wide range of AI adoption scenarios. To safeguard the privacy and confidentiality of individuals and organizations, all data used in this analysis were anonymized and compiled.

Analysis and Interpretation

The table 1 provides information on the gender, industry, roles, and experience of 43 individuals. In terms of gender, 67% of the individuals are male, while 33% are female. The roles of the individuals are also listed, with assistant managers having the highest count at 28%, followed by customer relationship managers and managers at 21% each. Finally, the experience of the individuals is divided into five categories, with 15-20 years of experience having the highest count at 33%, followed by 11-15 years at 28%.



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The table 2 shows the responses of 43 individuals to questions about their familiarity and adoption of certain financial services. The table is divided into two sections: Familiarity and Adoption. The Familiarity section shows that out of the 43 individuals, 30 are familiar with AMC, banking, insurance, wealth management, credit and lending services, financial markets, real-estate finance, and others, while 13 are not familiar with these services. The Banking industry has the highest count of individuals who are familiar with it at 9, followed by Insurance at 6. The Adoption section shows that out of the 43 individuals, 22 have adopted these services, while 21 have not. Banking has the highest count of individuals who have adopted it at 9, followed by AMC and Financial Markets at 2 each.

The table 2.1 shows the amount of variation that is due to systematic differences between the regression model and the model with no independent variables. The df for this row is 2, which means that there are two independent variables in the model. The F-value for the Regression row is greater than 1, which indicates that the regression model provides a better fit to the data than the model with no independent variables. The Significance F value is less than 0.05, which means that the regression model is statistically significant. The presented table 3 provides information on the responses of 43 individuals to various themes related to finance and risk management. The table has 13 rows, each representing a theme, and three columns: Serial number, Theme, and Responses. The themes include Operational Efficiency, Customer Experience, Risk Management, Investment Strategies, Regulatory Compliance, Cyber security, Financial Forecasting, Loan Approval Process, Contract Analysis, Blockchain and Smart Contracts, Financial Inclusion, and Data Analysis and Insights. The table provides insights into the areas of finance and risk management that individuals are most interested in, which can be useful for identifying trends and making informed decisions. The table 4 provides information on the top concerns of different industries related to finance and risk management. The responses range from 0 to 3, with Customer Trust and Literacy having the highest count at 10, followed by Talent Shortage at 9, and Data Privacy and Security and Regulatory Compliance at 4 each. The table provides insights into the areas of finance and risk management that different industries are most concerned about, which can be useful for identifying trends and making informed decisions. The presented F-Test Two-Sample for Variances table 4.1 provides information on the challenges faced by different industries related to finance and risk management. The table shows that the mean and variance of the challenges vary across different industries. The F-value for the table is 1.77494, and the $P(F \leq f)$ one-tail is 0.03319. The F Critical one-tail is 1.67097.

Bootstrap Resampling Statistics

The presented Bootstrap Statistics figure 3 provides information on the mean and 95% confidence interval of the challenges faced by different industries related to finance and risk management. The table has three columns: Industry, Mean, and 95% Confidence Interval. The mean of the challenges for Banking is 3.9388, and the 95% confidence interval is between 3.2558 and 3.6279. The mean of the challenges for Insurance is 4.1529, and the 95% confidence interval is between 4.6976 and 4.6744. The confidence interval indicates that we can be 95% confident that the true population mean falls within the given range. The given table 5 and Figure 4 provides a count of the content related to artificial intelligence (AI) in finance. The table lists various AI-related topics and the number of times they appear in the search results. The most common content is Automation, with a count of 20, followed by Algorithmic trading and Chat bots with a count of 18. Blockchain, Asset management, and High-frequency trading are also among the top five with counts of 17, 16, and 14, respectively. The table also includes other topics such as Risk management, Cyber security, Insurtech, Crowd-sourced, RPA, Predictive and Algorithmic risk, Fraud detection, Natural language processing, Data-driven, Peer-to-peer lending, Customer service, Smart contracts, Regulatory Compliance, Wealth management, Supply Chain finance, RegTech, Personalization, Explainable AI, Quantum computing, Voice recognition, Digital identity verification, Real-time data analysis, Data privacy, Credit scoring, Anti-money laundering, Automated customer onboarding, Machine learning, Behavioral analytics, and Robo-advisors.

Findings and Suggestions

Thirty out of the 43 people polled knew about different financial services, and 22 of them had used these services. Most people knew about and used banking the most. The thematic analysis showed that people in the financial



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services business care most about operational efficiency and customer experience. These themes got the most responses, which shows how important they are in the business. Different industries have said that the biggest problems with using AI in financial services are linked to customer trust and literacy, a lack of talent, and data privacy and security. Several new developments and trends in AI for financial services were found through the text analysis. Some of the most talked about trends were automation, algorithmic trade, chatbots, and blockchain. The regression analysis showed that the use of AI made challenges in the financial services business less difficult in a way that was statistically significant. AI knowledge, on the other hand, did not make a statistically important difference. To make up for the lack of people with AI skills in the financial services business, they should focus on developing and keeping talent. Financial institutions should keep putting money into adopting AI because it helps solve problems in the business. Employees should be educated and trained on how to use AI tools and technologies in the best way possible. To make sure AI is used in a responsible way, policymakers and regulators should work closely with the financial industry to solve problems with data privacy, legal compliance, and cybersecurity.

Financial institutions should look into how blockchain and smart contracts could make their processes more secure, transparent, and efficient. AI applications in risk management, fraud detection, and customer service should continue to be improved through research and development. This will make the industry more stable and improve customer happiness. Financial companies should think about automating the process of signing up new customers to make things run more smoothly and improve the customer experience. In a rapidly changing financial environment, it's important to keep an eye on AI-driven trends and technologies and adapt to them in order to stay competitive and legal. The customer experience is still very important. Financial companies should use personalized services and chatbots that are powered by AI to make customers happier and more engaged. It is important to address concerns about data privacy and protection. To build and keep customer trust, organizations should put money into strong cybersecurity steps and make sure they follow the rules. Given the problem of a lack of talent, institutions should put money into talent development programs to build a skilled staff that can manage AI implementations well. Financial professionals should keep up with new AI trends, like blockchain and high-frequency trading, so they can adapt to new possibilities and take advantage of them. As the use of AI continues to grow, companies must put ethics first, including fairness, transparency, and reducing bias, to make sure AI is used in a responsible way.

CONCLUSION

Due to the use of AI technologies, the financial services business is going through a lot of changes and disruptions. AI is not only making the operations more efficient, but it is also making the customer experience better, especially with the help of robots and automation. But problems like data privacy, a lack of ability, and cyber security must be solved. The study found that using AI helps solve problems in the business. This shows how important it is to keep investing in AI technologies. Efficiency in operations and putting the customer first are still important goals for financial institutions. As AI keeps changing, it's important for people who work in the field to know about new trends and social concerns. The digital disruption of the financial services business is now driven in large part by artificial intelligence. It has an effect on many things, such as operational efficiency, risk management, how customers feel, and investment plans. Even though there are challenges and worries, like data safety and following the rules, the benefits of using AI are clear. As financial companies continue to use AI and they need to find a balance between being innovative and doing the right thing. Policymakers, regulators, and industry players need to work together to make a regulatory framework that encourages innovation while keeping customers safe and secure. By tackling problems and embracing AI-driven innovations in a responsible way, the financial services ecosystem can survive the digital disruption and grow in the AI-driven era. With automation and algorithmic trading at the center of development, the future of AI in financial services looks bright. As AI technologies change, financial institutions must be flexible and quick to adopt them in order to stay competitive and meet customer needs. The financial services ecosystem can make it through this time of digital disruption by dealing with problems and accepting AI-driven trends.





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Table 1 Demographic Profile

Gender	Count	%
Male	29	67%
Female	14	33%
Total	43	100%
Industry	Count	%
Banking	9	21%
Insurance	6	14%
Asset Management Company	5	12%
Financial Markets	7	16%
Credit and Lending Services	3	7%
Wealth Management	5	12%
Real-Estate Finance	3	7%
Others	5	12%
Total	43	100%
Roles	Count	%
Customer Relationship Managers	9	21%
Chief Financial Officer	2	5%
Chief Investment Officer	2	5%
Chief Operations Officer	1	2%
Managers	9	21%
Assistant Managers	12	28%
Others	8	19%





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Total	43	100%
<i>Experience</i>	<i>Count</i>	<i>%</i>
0 - 5 Years	3	7%
6 - 10 Years	6	14%
11 - 15 Years	12	28%
15 - 20 Years	14	33%
Above 21 Years	8	19%
Total	43	100%

Source: Survey data (2023)

Table 2 Familiarity and Adoption of AI in Financial Services Industry

Response	AMC	Banking	CLSERV	FINMKT	Insurance	Others	REFIN	WM	Grand Total
Familiarity									
Yes	3	9	1	5	4	4	1	3	30
No	2	0	2	2	2	1	2	2	13
Grand Total	5	9	3	7	6	5	3	5	43
Adoption									
Yes	2	9	0	3	4	2	0	2	22
No	3	0	3	4	2	3	3	3	21
Grand Total	5	9	3	7	6	5	3	5	43

Source: Survey data (2023)

Table 3 Impact of AI in Financial Services Industry Thematic Analysis

S.No	Theme	Responses
1	Operational Efficiency	6
2	Customer Experience	8
3	Risk Management	4
4	Investment Strategies	3
5	Regulatory Compliance	2
6	Cyber security	2
7	Financial Forecasting	6
8	Loan Approval Process	6
10	Contract Analysis	1
11	Blockchain and Smart Contracts	1
12	Financial Inclusion	2
13	Data Analysis and Insights	2
	Total	43

Source: Interview data (2023)

Table 3.1 Regression analysis

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	57.1334	28.567	6.25182	0.004339
Residual	40	182.774	4.5693		
Total	42	239.907			





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	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.958	1.0873	0.88	0.383	-1.239	3.156	-1.24	3.156
Familiarity	-0.855	0.9605	-0.89	0.378	-2.797	1.086	-2.8	1.086
Adoption	2.761	0.8825	3.12	0.003	0.977	4.545	0.978	4.545

Source: Interview data (2023)

Table 4 Challenges and Concerns in Implementing AI solutions in financial services.

Industry	Data Privacy and Security	Regulatory Compliance	Talent Shortage	Scalability	Customer Trust and Literacy	Cyber security Threats	Others
Banking	1	2	3	1	0	2	0
Insurance	1	0	2	0	2	0	1
Asset Management Company	0	0	0	0	2	0	3
Financial Markets	0	0	1	2	2	2	0
Credit and Lending Services	0	0	1	0	2	0	0
Wealth Management	1	1	1	0	2	0	0
Real-Estate Finance	0	0	1	2	0	0	0
Others	1	1	0	1	0	1	1
Grand Total	4	4	9	6	10	5	5

Source: Survey data (2023)

Table 4.1 F-Test Two-Sample for Variances		
	Industry	Challenges
Mean	3.95348	4.13953
Variance	5.71207	3.21816
Observations	43	43
df	42	42
F	1.77494	
P(F<=f) one-tail	0.03319	
F Critical one-tail	1.67097	

Source: Survey data (2023)

Table 5 Future Developments or current trends in AI within financial services Content Analysis

S.No	Content	Count
1	Automation	20
2	Algorithmic trading, Chat bots	18
3	Blockchain	17
4	Asset management	16
5	High-frequency trading	14
6	Risk management, Cyber security, Insurtech, Crowd-sourced	12
7	RPA, Predictive and Algorithmic risk	11
8	Fraud detection	10
9	Natural language processing, Data-driven, Peer-to-peer lending	9
10	Customer service, Smart contracts, Regulatory Compliance	8
11	Wealth management, Supply Chain finance	7





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12	RegTech, Personalization, Explainable AI, Quantum computing, Voice recognition, Digital identity verification, Real-time data analysis	6
13	Data privacy, Credit scoring, Anti-money laundering	5
14	Automated customer on boarding	4
15	Machine learning, Behavioural analytics	3
16	Robo-advisors	2

Source: Interview data (2023)

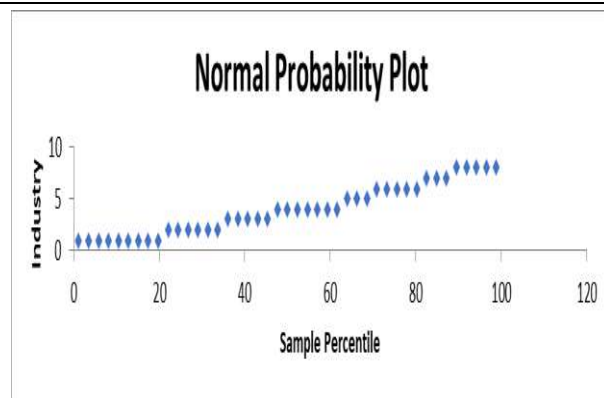


Figure 1 Normal Probability Plot

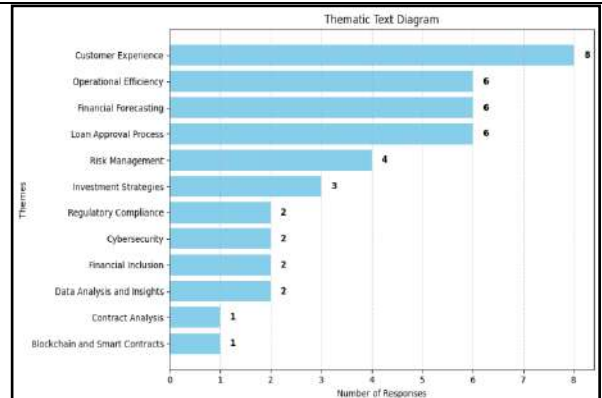


Figure 2 Thematic diagram

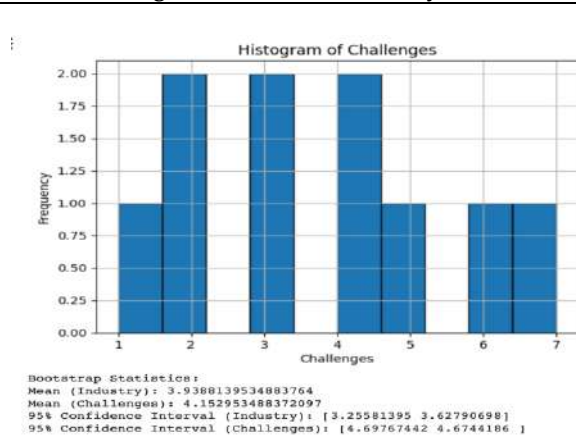


Figure 3 Challenges and Concerns in Implementing AI



Figure 4 Future Developments or current trends in AI





Preliminary Physicochemical, Phytochemical, and Biochemical Analysis of *Kurunthotti Kudineer Chooranam*: A Polyherbal Siddha Formulation

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ABSTRACT

In this scientific world, the standardization of Siddha formulations is imperative. Herbal preparations are safe to use, according to conventional wisdom, and an increasing number of people are consuming them worldwide. Standardizing herbal formulas is essential for assessing the drug's effectiveness, safety, and purity. The therapeutic effectiveness of Siddha medicine depends on the quality of herbal raw materials and appropriate procedures for developing herbal formulations. The assurance of the safety and efficacy of herbal drugs requires monitoring of the quality of the product from collection through processing to the finished packaged product. The principal intention of this current study is to standardize the Siddha formulation, *Kurunthotti Kudineer Chooranam* [KKC]. The formulation is subjected to preliminary physicochemical, phytochemical, and biochemical evaluation by *Kurunthotti Kudineer Chooranam*, which was carried out following the standard procedure as per the Protocol for Testing of Ayush Medicine published by PLIM [Pharmacopeia Laboratory of Indian Medicine], Ministry of Ayush, Ghaziabad. KKC was prepared as per the method described in the classical Siddha literature. The organoleptic characteristics of the *Kurunthotti Kudineer Chooranam* are in Solid form, which is brownish in color and fine to touch with a characteristic odour and astringent taste, which reveal the quality of the formulation,





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and the physicochemical analysis was screened for the loss of drying, total Ash value, acid-insoluble ash, water-soluble extractive value, alcohol-soluble extractive value, and being free from aflatoxin to estimate the quality of the study drug. The results of the preliminary phytochemical test showed that KKC reveals the presence of alkaloids, carbohydrates, glycosides, phytosterol, saponins, phenols, tannins, flavonoids, proteins, and amino acids.

Keywords: *Kurunthotti Kudineer Chooranam*, physicochemical analysis, phytochemical analysis, biochemical analysis.

INTRODUCTION

People have been turning to traditional remedies in recent times to maintain healthy lifestyles. Nowadays, medicinal plants and herbal preparations are mainly used because they have fewer side effects and are rich in active ingredients. More herbal products become available on the market. An herbal medicine's quality is the culmination of all the elements that either directly or indirectly support the product's acceptability, safety, and effectiveness. The quality of herbal products can now be tested with new and improved instruments [1]. These tools are important for making sure the products are effective and safe to use. Analytical tests are very important for checking if raw drugs are real, consistent, and of good quality. Choosing real drugs for making traditional medicines is very important right now [2]. However, herbal contamination and misidentification can have a negative impact on the pharmaceutical industry, paving the way for the standardization of herbal medicine. Standardization consistently communicates information regarding chemical, biological, and physicochemical profiles and heavy metal content. Preliminary standardization steps are essential to identify the original drug and establish analytical standards. Standardization of herbal preparations is essential for assessing drug quality, potency, and effectiveness. WHO and Ayush insisted on following many quality control guidelines to achieve better standardization of medicines. The Siddha system of medicines includes a large number of safe and valuable medicinal plants, which have better therapeutic effects in raw or processed form and are used clinically by Siddha practitioners. For the treatment of neurological disorders, the Siddha medical system offers a variety of drugs. *Kudineer* is a medication in decoction form. It's among the 32 internal remedies found in the Siddha literature method [3]. One such formula in clinical practice is *Kurunthotti Kudineer Chooranam* [4], which consists of 6 herbs and has been used to manage and *vatham* [Siravatham] [5], kind of disease Cerebral palsy. There is no much work carried out regarding the standardization of the compound formulation KKC. In this study, *Kurunthotti Kudineer Chooranam* was filtered for standardization procedure as per PLIM procedures [6]. The intention of this research is to give information about the standardization of KKC through physicochemical, phytochemical and biochemical analysis.

MATERIALS AND METHODS

Collection of Raw Drugs

The required drugs were purchased from a reputed raw drug shop at Kandha Swamy Kovil Street, Paris Corner, Chennai, Tamil Nadu. The raw materials have gotten authentication from the Department of Medicinal Botany, the National Institute of Siddha, and Chennai-47.

Pharmaceutical Study

Purification of raw drugs and preparation of drugs were done at the Department of Gunapadam [Pharmaceutical Laboratory], National Institute of Siddha, Chennai-47.

Kurunthotti Kudineer Chooranam was prepared with the ratio mentioned in Table 1.





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Preparation of the Trial Drug Kurunthotti Kudineer Chooranam[KKC]**Method of Preparation**

All purified drugs are coarsely powdered. The prepared medicine was also authenticated by the concerned head of the department for its completeness.

Dosage: 2 to 4 years: 30 ml [bds].; 5 to 7 years: 40 ml [bds].

Duration: 2 Mandalam [90 days]., **Indication:** Vatham.

Drug Storage: Prepared medicine was stored in a clean and dry container.

Dispensing: Prepared medicine would be given in coarse powder form in separate air lock covers.

Organoleptic Character:

State, nature, odor, touch, appearance, and taste were noted. Organoleptic evaluation of *Kurunthotti Kudineer Chooranam* was carried out using traditional and standard techniques.

All the following studies were accomplished at the Tamil Nadu Dr. MGR Medical University, Guindy, Chennai-47.

Physicochemical Analysis was done [9, 10].**Loss on Drying [9]**

The exact weight of the test medication was measured in an evaporating dish. After five hours of drying at 105 degrees Celsius, the sample was weighed.

Determination of Total Ash [10]

The test drug was precisely weighed in a silica dish and burned in the furnace at 400 °C until it turned white, signifying the absence of carbon. Based on the weight of the medication that had been air-dried, the percentage of total ash was computed.

Determination of Acid-Insoluble Ash

We will boil 25 milliliters of diluted hydrochloric acid for six minutes with the ash that results from the total ash test. After gathering all of the insoluble material in the crucible, it is lit to a constant weight, cleaned with hot water, and burned. Using the weight of air-dried ash as a reference, the percentage of acid-insoluble ash will be determined.

Determination of Water-Soluble Ash

In the total ash test, the ash obtained will be boiled with 25 ml of water for 5 minutes. The insoluble matter collected in the crucible will then be washed with hot water and burned for 15 minutes at a temperature not exceeding 450 °C. The weight of the soluble matter is subtracted from the ash; the difference in weight indicates the water-soluble ash. To calculate the percentage of water-soluble ash for the air-dried drug.

Determination of Alcohol Soluble Extractive [11, 12].:

To prepare the test sample, 100 ml of alcohol was poured into a closed flask and macerated for twenty-four hours, shaking frequently for six hours, and allowed to stand for eighteen hours. Filter rapidly, taking care to avoid loss of solvent. Eject 25 ml of filtrate into a tared, flat, shallow dish, evaporating to dryness. Dry at 105 °C to a constant temperature and weight. Calculate the percentage of alcohol-soluble extractives in the air-dried drug.

Determination of Water-Soluble Extractive [11, 12].:

The test sample was then macerated in a closed flask with 100 ml of chloroform water for twenty-four hours, shaken frequently for six hours, and allowed to stand for eighteen hours. Filtration: Filter rapidly, taking care not to lose solvent. Evaporate 25 ml of the filtrate to room temperature in a tared, flat-bottomed, shallow dish. Dry: Dry at 105°C with constant weight. Calculate the percentage of water-soluble extract relative to the air-dried drug.

Phytochemical Analysis Was Done for the Following Tests**Detection of Alkaloids**

Each extract was dissolved in a small amount of diluted hydrochloric acid before being filtered.

- Mayer's Test:** Filtrates were treated with Mayer's reagent [potassium mercuric iodide]. Alkaloids can be detected by the formation of a yellow-colored precipitate.
- Wagner's Test:** Filtrates were treated with Wagner's reagent [iodine in potassium iodide]. The formation of a brown or red precipitate indicates the presence of alkaloids.





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- c. **Dragendorff's Test:** The solution of potassium bismuth iodide, known as Dragendorff's reagent, was applied to the filtrates. Alkaloids can be detected by the formation of a red precipitate.
- d. **Hager's Test:** A solution of saturated picric acid was used as Hager's reagent to treat the filtrates. A yellow precipitate's formation indicates the presence of alkaloids.

Detection of Carbohydrates

The extracts were dissolved individually in 5 ml of distilled water and filtered. The filtrate was used to test for the presence of carbohydrates.

- a. **Molisch's Test:** To 2 ml of plant sample extract, two drops of an alcoholic solution of α -naphthol are added. The mixture is shaken well, and a few drops of concentrated sulfuric acid are added slowly along the sides of the test tube. A violet ring indicates the presence of carbohydrates.
- b. **Benedict's test:** Filtrates were treated with Benedict's reagent and heated gently. The presence of reducing sugars is indicated by the orange-red precipitate.

Detection of Glycosides

The extract was hydrolyzed with dil.HCL and then tested for glycosides.

Modified Borntrager test: The extract is treated with a ferric chloride solution and immersed in boiling water for about 5 minutes. Equal parts of benzene were added to the mixture after it had cooled. The benzene layer is separated and treated with an ammonia solution. The formation of a pink color in the ammonium layer indicates the presence of anthranol glycoside.

Cardiac glycosides [Keller-Killiani test]: shake the extract with distilled water [5 ml]. Then add glacial acetic acid [2 ml], containing a few drops of ferric chloride, followed by H₂SO₄ [1 ml]. along the side of the test tube. The formation of a brown ring at the interface indicates a positive signal for cardiac glycosides, and a purple ring may appear below the brown ring.

Detection of Saponins

Foaming test: The extract was diluted with distilled water to 20 ml and stirred in a graduated cylinder for 15 minutes. The formation of a 1 cm-thick foam layer indicates the presence of saponins.

Foam test: 2 ml of water and 0.5 g of extract were shaken. If the foam created persists for 10 minutes, this indicates the presence of saponin.

Detection of Phytosterols

Salkowski test: The extract is treated with chloroform and filtered. The filtrate was treated with a few drops of conc. sulfuric acid, shaken, and let stand. The golden-yellow appearance indicates the presence of triterpenes.

Detection of Phenol Ferric Chloride Test

The extracts were treated with 3 to 4 drops of ferric chloride solution. The formation of a bluish-black color indicates the presence of phenol.

Tannin Detection and Gelatin Test

Dissolve the extract in 5 ml of distilled water and add 2 ml of a 1% gelatin solution containing 10% NaCl. A white precipitate indicates the presence of phenolic compounds.

Detection of Flavonoids

- a. **Alkaline Reagent Test:** The extract is treated with a few drops of sodium hydroxide solution. The formation of a deep yellow color, which then becomes colorless with the addition of dilute acid, indicates the presence of flavonoids.
- b. **Lead Acetate Test:** Treat the extract with a few drops of lead acetate solution. The presence of flavonoids is indicated by the formation of a yellow precipitate.





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Detection of Proteins and Amino Acids

- Xanthoprotein Assay:** Extracts were treated with a few drops of conc. Nitric acid. The formation of a yellow color indicates the presence of protein.
- Ninhydrin Test:** Add 0.25% w/v ninhydrin reagent to the extract and boil for a few minutes. The formation of a blue color indicates the presence of amino acids.

Detection of Diterpenes in the Copper Acetate Test

Extracts were dissolved in water and treated with 3–4 drops of copper acetate solution. The formation of an emerald-green color indicates the presence of diterpenes.

Gums and Mucus

To 1 ml of extract, add 2.5 ml of pure alcohol and stir continuously. The precipitate was then air-dried and its swelling properties tested. Swelling is observed, indicating the presence of gum and mucus.

Testing of Fixed Oils and Greases

In situ testing: A small amount of extract is pressed between two sheets of filter paper. Oil stains on paper indicate the presence of fixed oil.

Test for Quinones

- The extract was treated with sodium hydroxide. A blue or red precipitate indicates the presence of quinones. Preliminary phytochemical studies on the Kurunthotti Kudineer Chooranam aqueous extract were carried out using standard procedures.
- The results are presented in table form. Current research shows that bioactive compounds are present in all extracts from Kurunthotti Kudineer Chooranam.

Biochemical analysis was done as per guidelines[13].

RESULTS AND DISCUSSIONS

Lack of standardization of herbal formulations creates difficulty in validating their efficacy and maintaining the quality of the product. Based on Ayush guidelines, herbal products need to be standardized before being placed on the market. Standardization of herbal formulations is essential in order to assess the quality of herbal drugs. *Kurunthotti Kudineer Chooranam* is a purely herbal product commonly used for the management of *siravatham* [cerebral palsy]. symptoms. Commercially procured *Kurunthotti Kudineer Chooranam* is a coarse powder that is brownish in color, possesses aroma flavor, and has an astringent taste. Touch exposes physical traits like the fineness and comparatively coarse powder of *Kurunthotti Kudineer Chooranam*. The results are tabulated in Table 2. The results of the physiochemical parameters are presented in Table 3. The percentage of loss on drying of *KKC* was calculated as 5.61%, and the moisture content of the sample and total ash content of 6.78% were found to be within a limit in *KKC*, which provides information on inorganic matters, respectively. It should be less than 10% as per regulation, which implies that *KKC* is free from impurities. Similarly, a high extractive value gives an idea of the amount of phyto constituents, and a lower extractive value indicates adulteration or substitution of drugs. In the present study, it was observed that the water-soluble extractive value was found to be higher than the alcohol-soluble extractive value. This result indicates that there was no external contamination during manufacturing. The phytochemical examination of *KKC* reveals the presence of alkaloids, carbohydrates, glycosides, phytosterols, saponins, phenols, tannins, flavonoids, proteins, and amino acids. Each of those is important in human medicine as well as an organism's natural defense [12]. The information obtained from the preliminary phytochemical screening will be fully utilized to elucidate the drug's true identity.





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Organoleptic Characters

Organoleptic evaluation of *Kurunthotti Kudineer Chooranam* was carried out using traditional and standard techniques. The organoleptic characters of KKC were determined, and the results are tabulated in Table 3.

Results for the Physicochemical Analysis of *Kurunthotti Kudineer Chooranam*:

The physicochemical parameters of KKC were determined, and the results are given in Tables 3 and 4.

Results: The results showed that no stains were identified in the test sample packed on the TLC plate compared to the standard, indicating that the sample was free of aflatoxin B1, aflatoxin B2, aflatoxin G1, and aflatoxin G2. They are grouped in the table:

Results for the analysis of phytochemical

The phytochemical parameters of KKC were determined, and the results are tabulated in Table 6.

Biochemical analysis of *Kurunthotti Kudineer Chooranam*: Show the table 7.

Interpretation

The acidic radicals test shows the presence of **Sulphate**.

Interpretation

The basic radical test shows the presence of **calcium, aluminum, zinc, and magnesium and the** absence of heavy metals such as lead, iron, arsenic, and mercury.

Interpretation

The Miscellaneous test detects the presence of alkaloids, tannic acid, phenol cresol, and hydroquinone.

CONCLUSION

Even in the modern day, standardization is an important topic. Finding out the truth about the drugs will make full use of the data gathered from the preliminary phytochemical screening. Therefore, the need to standardize different herbal formulations will pave the way for discovering the therapeutic effects asserted in the Siddha literature and thereby enhance the scientific reputation of Siddha medicine. Given the widespread acceptance of herbal products as treatments for a variety of illnesses and the mounting evidence of the risks associated with the indiscriminate use of some herbs, standardizing herbal products is now imperative.

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Table 1: Composition of Kurunthotti Kudineer Chooranam[7].

S.no	Name	Botanical name	Part used	Part
1	Kurunthotti	Sida Rhomphoidus	Root	20.4 gm
2	Thazhuthazhai	Clerodendrum Phlomidis	Root	10.2 gm
3	Mazhil	Mimusop Elengi	Flower	20.4 gm
4	Naagaram	Zingiber officinalae	Dried Rhisome	5.1 gm
5	Maruvu	Majorana hortensis	Full plant	15.3 gm
6	Devatharam	Cedrus Deodara	Wood	10.2 gm

Table 2: Process for Purification:

The purification procedure was accomplished as per classical Siddha literature [8].

S.no	Name	Purification Procedure
1	Kurunthotti	Cut into small pieces, washed in river water, and dried.
2	Thazhuthazhai	into a small piece, washed in river water, and dried
3	Mazhil	Remove the calyx, androecium, and stalk.
4	Naagaram	Add 2 parts of sunnakkal to 1 part of Zingiber officinalae. Dry it for 3 hours, wash it, and then dry it. After that, the external skin should be peeled off.
5	Maruvu	Remove the calyx, androecium, and stalk.
6	Devatharam	Roasted to golden color.

Table 3 : The organoleptic characters of KKC were determined

Parameter	Results
State	Solid
Nature	Moderately Coarse powder
Odor	Pleasant
Touch	Fineness
Appearance	Brownish
Taste	Astringent



**Table 4 : The physicochemical parameters of KKC**

SL.No.	Parameters	Results
1	Loss on Drying	5.61%
2	Total Ash	6.78%
3	Acid insoluble Ash	1.53%
4	Water soluble Ash	2.02%
5	Water Soluble Extrative	12.75%
6	Alcohol Soluble Extrative	11.48%

Table.5. Aflatoxins content of KKC

	Aflatoxins				
Formulations	B1	B2	G1	G2	AYUSH Permissible Limit
Kurunthottikudineer	ND	ND	ND	ND	B1& G1: 0.5 ppm

ND: Not detected.

Table 6 : The phytochemical parameters of KKC

SL.No	Phytochemicals	Test Name	H2O Extract
1	Alkaloids	Mayer's Test	+ve
		Wagner's Test	+ve
		Dragendroff's Test	-ve
		Hager's Test	-ve
2	Carbohydrates	Molisch's Test	+ve
		Benedict's Test	+ve
3	Glycoside	Modified Borntrager's Test	-ve
		Keller Killaini	-ve
4	Saponin	Froth Test	+ve
		Foam Test	-ve
5	Phytosterol	Salkowski's Test	-ve
6	Phenols	Ferric Chloride Test	-ve
7	Tannins	Gelatin Test	-ve
8	Flavonoids	Alkaline Reagent Test	+ve
		Lead acetate Test	+ve
9	Proteins and amino acids	Xanthoproteic Test	-ve
10	Diterpenes	Copper Acetate Test	+ve
11	Gum & Mucilage	Extract + Alcohol	-ve
12	Fat & Fixed Oil	Spot Test	-ve
13	Quinones	NAOH + Extract	+ve

Table 7: Results of Acid radicals studies

SL. NO	Parameter	Observation	Result
1	Test for Sulphate	Cloudy appearance Present	Positive
2	Test for Chloride	-	Negative
3	Test For Phosphate	-	Negative
4	Test For Carbonate	-	Negative
5	Test For Nitrate	-	Negative





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6	Test for Sulphide	-	Negative
7	Test For Fluoride & oxalate	-	Negative
8	Test For Nitrite	-	Negative
9	Test For Borax	-	Negative

Table 8: Results of basic radical's studies:

SL.NO	Parameter	Observation	Result
1	Test for Lead	-	Negative
2	Test for Copper	-	Negative
3	Test For Aluminium	Brown precipitate is formed	Positive
4	Test For Iron.	-	Negative
5	Test For Zinc	White precipitate is formed	Positive
6	Test for Calcium	Cloudy appearance and white precipitate present	Positive
7	Test For Magnesium	White precipitate obtained	Positive
8	Test For Ammonium	-	Negative
9	Test For Potassium	-	Negative
10	Test For Sodium	-	Negative
11	Test For Mercury	-	Negative
12	Test For Arsenic	-	Negative

Table 9: Miscellaneous

SL.NO	Parameter	Observation	Result
1	Test for Starch	-	Negative
2	Test for Reducing sugars	-	Negative
3	Test For Alkaloids.	Yellow colour developed	Positive
4	Test For Tannic acid.	Blue-black precipitate obtained	Positive
5	Test for unsaturated compounds	-	Negative
6	Test for Amino acid	-	Negative
7	Test For Type of compounds	Blue colour developed	Phenol cresol and hydroquinone are present





RESEARCH ARTICLE

Assessment of Prevalence, Etiology, Prescribing Patterns, Awareness among Women towards Abnormal Uterine Bleeding and its Effects on Quality of Life

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ABSTRACT

Abnormal uterine bleeding is defined as excess bleeding from the uterus than that of usual. this is the major complication that will affect the quality of life of women. here we have included 164 subjects to find out the quality of life by using SF 36 health survey questionnaire and to find out the subject's knowledge regarding menstruation by using self-framed questionnaire and the data was analyzed. From the results the most common etiology was found to be ovulatory dysfunction (71%), norethisterone is most frequently prescribed in hormonal treatment, Tranexamic acid (Anti – fibrinolytic) & Mefenamic acid (NSAID) are mostly prescribed in non-hormonal drug and finally we have concluded that treatment will improve the quality of life of women with abnormal bleeding. All patients have good knowledge about general menstruation and inadequate knowledge about treatment and disease.

Keywords: Menstruation, prevalence, abnormal uterine bleeding, quality of life.





INTRODUCTION

Abnormal uterine bleeding (AUB) is the most common but complicated clinical presentation (Albers *et al.*, 2004). There can be no other disease or condition that affects so many females regularly (Cheong *et al.*, 2017). AUB includes a greater number of symptoms, like inter menstrual bleeding, heavy menstrual bleeding, and a combination of both heavy and prolonged menstrual bleeding. It is a common menstrual problem, affecting 10 - 30% of women of the reproductive age group and 50% during the perimenopausal period (Cheong *et al.*, 2017) (Singh and Choudhary 2018) (Chodankar Critchley 2019). The average menstrual cycle occurs over 4.5 to 8 days every 24 to 38 days and per cycle 5 and 80 ml volume of blood loss will be there (Cheong *et al.*, 2017) (Tamilzhelviet *et al.*, 2019). Menorrhagia is defined as menstrual blood loss > 80 ml or a period lasting more than eight days (Kotagasti 2015) (Cheong *et al.*, 2017).

International Federation of Gynecology and Obstetrics (FIGO) Menstrual Disorders Working Group in 2011 approved a new PALM – COEIN classification to assess the causes of AUB (Cheong *et al.*, 2017) (Sun *et al.*, 2018) (Tamilzhelvi *et al.*, 2019). PALM comprising of structural pathologies and stands for different types of cancers which includes Polyp, Adenomyosis, Leiomyoma and Malignancy. The COEIN classification which contains or represents non-structural causes and it includes Coagulopathy, Ovulatory disorders, Endometrial, Iatrogenic, and Not otherwise classified (Sun *et al.*, 2018) (Tamilzhelvi *et al.*, 2019). From the AUB mortality and severe complications are extremely rare. The AUB severity is characterized based up on its impact on the quality of life which is related to health (Liu *et al.*, 2007). However, AUB is closely associated with lower quality of life with increased healthcare expenses that may affect the risk of comorbidities in women (Kazemijaliseh *et al.*, 2017).

The Management of AUB includes both medical therapies (Hormonal & Non – hormonal) and surgical procedures (Liu *et al.*, 2007) (Wilkinson Kadir 2010). Medical therapy includes the medicines like Levonorgestrel IUD, Tranexamic acid, Oral contraceptives, either estrogens and progestins or synthetic progestins, and used only 21 days a month (Marret *et al.*, 2010). When medical therapy failed then surgical intervention may be required (Albers *et al.*, 2004) (Chodankar Critchley 2019). Hysterectomy for adenocarcinoma, Myomectomy for leiomyomas, Transcervical endometrial Hysteroscopic resection, Dilation and curettage are mostly available (Albers *et al.*, 2004) (Marret *et al.*, 2010).

Based on their understanding of menstruation, women's perception of what is normal regarding menstruation depends (Kaure *et al.*, 2015). Thus, there is a need to identify the knowledge gaps about how heavy menstrual bleeding affects women's lives so that the appropriate treatment and support can be offered (Bhatiyani *et al.*, 2017). The blood loss prevalence has been found to be the range from 9 to 14% When measured quantitatively as blood loss more than 80 ml, and blood loss prevalence has been found as high as 52% when measured qualitatively (Bitzer *et al.*, 2013) (Bhatiyani *et al.*, 2017). Menorrhagia will show the effect on the personal, social, family, and work – life of women and further results in reduction of their quality of life. Menorrhagia is mostly responsible for iron deficiency anemia, which has adverse effects on women's health (Gokyildiz *et al.*, 2013).

The Short Form 36 Health Survey Questionnaire (SF 36) is the most widely used instrument to find out or to measure the quality of life. (Karlsson *et al.*, 2014). This questionnaire is a self-evaluated and self – reported instrument that contain 36 items, and will provide an assessment in eight domains. The traditional scores of each domain range from 0 to 100, where 100 are the highest score having good health whereas 0 indicates the lowest SF 36 score stating the worse quality of life (Karlsson *et al.*, 2014). The reason to select this topic is due to the lack of awareness among women regarding abnormal bleeding in the surrounding areas. They have been frequently affected by these common issues and have struggled to find a solution in a short time. So, this study helps them understand their problem and get the proper medical attention they need, which improves their quality of life.





MATERIALS AND METHOD

Study Site

This study was conducted at Indian Hospital in Bhimavaram. It is a tertiary care hospital and treats patients in Bhimavaram and nearby areas regarding various Gynecological disorders. The hospital is specialized in the Gynecology department.

Study Design

The study was a Prospective and Observational study. It includes the participation of 164 patients. Over a period of six months the study was carried out from August 2019 to January 2020.

Source of Data and Materials

Method of Collection of Data

- Patient interview
- Patient case report and prescription

Method of Collection of Material

- Patient consent form
- Patient health – related quality of life documentation form (SF36)
- Patient educational status from (Self framed questionnaire)
- Patient data collection form.

Study criteria

Inclusion Criteria

- Adolescent girls
- Premenopausal and postmenopausal women

Exclusion Criteria

- Patients who are not willing to participate in the study
- Menopause women
- Pregnant women

Study Procedure

Method of Data Collection

Before the initiation of the study, we have obtained an approval of ethical clearance from the Institutional Ethical Committed. Based up on the inclusion and exclusion criteria, Patients who were coming to the hospital regarding the disease in the outpatient department were screened. Subjects were enrolled for the study who met the inclusion criteria. from the patients or the attenders of the patient Informed consent was obtained. after two months during their next hospital visit follow up was done. By interviewing patients and by observing case notes Details regarding the etiology, current therapy was obtained. By using patient data collection form for present medication Patient therapy was monitored. The prevalence of AUB is assessed by using the epidemiological data.

Assessment of Health-Related Quality of Life

According to the study design, by using a generic scale SF36 patient's health-related quality of life was measured. By using appropriate questionnaires, collection of patient health-related issues according to their quality of life was done and assessment was done by using scores that are present in the scale.

Assessment of Knowledge of Women with AUB

Knowledge of women towards AUB is measured by using a self – framed questionnaire.



**Kondeti Renusri et al.,****Statistical Methods**

Prescribing patterns of abnormal uterine bleeding are evaluated. Quality of life (QOL) of patients is evaluated by using SF36 Descriptive statistics of demographic and clinical variables included frequencies, percentages and mean, SD. For the domains (subscales) of SF36 Mean scores before and after treatment were calculated. To determine if the change detected from the before and after treatment was significant a paired t-test was used. By using GraphPad Prism (8.3.0), all statistical analyses are performed.

RESULTS

Data was collected from 164 women with abnormal uterine bleeding. The total number of gynec patients who attended the hospital in 6 months' time period is 7200. The total prevalence rate is 2.3%. Figure 1 shows frequency distribution of age of women with AUB among 164 patients. This shows that among 164 women with abnormal uterine bleeding, 35 (21%) are of 10 – 20 years, 76 (46%) belongs to the age group of 21 – 30 years, 31 (19%) women belongs the age group of 31 – 40 years, 19 (12%) in 41 – 50 years and 3 (2%) women are in 51 – 60 years. Figure 2 represents the distribution of women based on PALM & COEIN classification. 128 women (78%) are in the COEIN group, followed by 36 women (22%) in the PALM group. This shows that COEIN (functional causes) contributed more to abnormal uterine bleeding in women than PALM (structural causes). Figure 3 shows the cause wise distribution. Among COEIN component, Ovulatory dysfunction contributed for the causes of AUB in 116 (71%) women of total sample, followed by endometrial dysfunction in 5 (3%) women and 6 (4%) women are under none classified. In PALM component Leiomyoma is the cause for 22 (13%) women, followed by polyp for 10 (6%) and adenomyosis for 5 (3%) of women. Figure 4 shows symptom wise frequency distribution of symptoms of AUB patients. 53 women out of 164 have Menorrhagia (32%), 45 have Oligomenorrhea (27%), 22 women have Polymenorrhagia (13%), 19 have Polymenorrhea (12%), 16 women have Hypomenorrhea (10%) and only 1 woman have Amenorrhea (1%). Figure 5 shows the treatment wise frequency distribution of symptoms of AUB patients. Among the treatment options available for AUB, 115 prescriptions are given with hormonal treatment, followed by 28 with Combinational treatment and 17 prescriptions with non – hormonal treatment and only 4 women are treated with surgery. Figure 6 shows the distribution of hormonal drugs. Among Hormonal drugs 47 (41%) of prescriptions are given with norethisterone (Oral progesterone) and 24 (21%) prescriptions with Medroxy progesterone acetate which are commonly prescribed among hormonal therapy. Remaining hormonal drug contributions are, Levonorgestrel + Ethinylestradiol & Medroxyprogesterone acetate, Levonorgestrel + Ethinylestradiol & Norethisterone, Norethisterone & Cyproterone acetate + Ethinylestradiol and Norethisterone & Ethinylestradiol.

Prescription pattern of non-hormonal drugs is shown in figure 7. 17 women out of 164 are given with non – hormonal management among which Tranexamic acid (Anti – fibrinolytic) & Mefenamic acid (NSAID) are mostly prescribed. Among 17 women 5 are given with Tranexamic acid, mefenamic acid, 3 women are given with Iron supplements and 1 woman with Amrta ayurvedic medicine and Hyoscinebutyl bromide. Table 1 shows the distribution of combinational drugs. Only 28 of the total sample are prescribed with combinational therapy. Combination drugs include, Levonorgestrel + Ethinylestradiol & Mefenamic acid, Desogestrel + Ethinylestradiol & Hyoscine butyl bromide, Cyproterone acetate + Ethinylestradiol & Mefenamic acid, Desogestrel + Ethinylestradiol & Iron supplements, Medroxyprogesterone acetate & Mefenamic acid, Misoprostol & Mefenamic acid, Levonorgestrel + Ethinylestradiol & Tranexamic acid, L + E & Iron supplements + Mefenamic acid.

Figure 8 shows the average health assessment scores before and after treatment. From the data collected through the questionnaire, the mean scores of the domain, general health is 50, role limitation due to physical health is 40, energy/fatigue is 58, pain is 56, emotional wellbeing is 73, physical functioning is 62, role limitation due to emotional problems is 58, social functioning is 72 and health change is 29. This shows that women with AUB had lower SF 36 scores for all eight subscales before treatment. The greater decrease is seen in general health, role limitation due to physical health, energy/fatigue, pain, role limitation due to emotional problems and health change. After three months of collecting data, women are followed up and showed an increase in the mean scores in all the eight



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subscales of SF36. Increased mean scores are seen in all the domains, good improvement is seen in general health (Mean = 74), role limitation due to physical health (Mean = 78), energy / fatigue (Mean = 76), pain (Mean = 82), role limitation due to emotional problems (Mean = 83) and health change (Mean = 70). After three months of follow up of women, significant improvement is seen in all the domains, mainly in general health, role limitation due to physical health, physical functioning & health change. Figure 9 shows the distribution of women based on their knowledge. 71% of women answered correctly about the questions included in the domain - general menstruation, 36% of women answered correctly for the questions in the Knowledge on disease and only 17% of women answered correctly for the questions included in knowledge on the disease.

DISCUSSION

In the present study, AUB was most prevalent in women of 20 – 40 years age group, which states that AUB is the most common condition in reproductive-aged women. Previous studies conducted in Chennai among 15240 women revealed that the most extensive group of women who attended OPD for the complaint of AUB were between 36 and 45 years (Tamilzhelvi *et al.*, 2019). A study conducted in the US among 198 women aged 12 – 21 years stated that nearly half (45%) of all the respondents were older adolescents (> 18 years) (Houston *et al.*, 2006). A study conducted in 5 European countries among 4506 women aged 40 years or less stated that the mean age group of recognition of HMB was 24 years and another study which was conducted in Jaipur among 200 women stated that women in the age group of 23 – 37 are most commonly affected with AUB (Fraser *et al.*, 2015) (Hooja *et al.*, 2016).

Some previous studies also stated that the majority of AUB was observed in women of 45 – 50 years (Singh and Choudhary 2018). AUB is commonly seen above 40 years of age, which is also similar to our study (Theresa 2017). At the onset of the menarche AUB may begin first. In women of reproductive age AUB is particularly prevalent but until menopause it continues to be a common problem. In the present study, the youngest women who presented with AUB were aged 12 years and the oldest women were 56 years. Similar findings were reported in a previous study that the youngest women presented with AUB were aged 11 (Tamilzhelvi 2019). FIGO developed the PALM – COEIN classification for sub – classifying AUB etiology. The diagnosis of AUB is made by using this classification. In this study, PALM – COEIN classification is used to determine the cause of AUB. COEIN component contributed more (78%) to the cause of AUB than PALM (22%). Similar findings were observed in a study conducted in China among 1053 women aged 15 – 55 years, who stated that COEIN component contributed more than PALM (Sun *et al.*, 2018). A study conducted in Bhopal (Singh and Choudhary 2018) included 953 postmenopausal women who have shown that the PALM component contributed more to the cause of AUB than COEIN, which is in disagreement to present study results (see figure 2).

Among COEIN group (AUB – O), Ovulatory dysfunction is the primary cause of AUB among functional causes contributing to 71% of all cases in the present study and AUB – L (Fibroids) was predominant in the PALM group contributing about (13%) of the total sample in structural causes. Similar results were observed in previous studies conducted in Bhopal among 953 women and in the Tertiary referral center in Chennai among 15240 women having gynecological complaints (Singh and Choudhary 2018) (Tamilzhelvi *et al.*, 2019). The present study results were not in line with a study conducted in Beijing Shijitan Hospital Gynecological Clinic included 1053 women as a population where the polyp is the major contributor among structural causes (Sun *et al.*, 2018). The most prevalent symptom of AUB is heavy menstrual bleeding having a major impact on the quality of life of women (Kotagasti 2015) (Singh and Choudhary 2018). In the present study, HMB (Menorrhagia) is the most commonly seen symptom which is followed by infrequent menstrual cycles (Oligomenorrhea). Similar results were found in previous studies conducted in Bhopal, Bangalore, Hyderabad, Australia, stating that HMB or Menorrhagia is the most commonly seen symptom among women with AUB, which majorly impacts QOL of women (Kotagasti 2015) (Weisberg *et al.*, 2016) (Singh and Choudhary 2018) (Sreelakshmi *et al.*, 2018). Generally, 5 – 8 days of bleeding is considered normal, if bleeding is seen for more than eight days, then it is considered abnormal or prolonged menstrual bleeding (Singh and Choudhary 2018). In the present study, 94 women had prolonged menstrual bleeding, which is similar to



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previous studies conducted in Bhopal among 953 women aged 40 and above and Hyderabad among 135 women aged 45 – 55 years (Singh and Choudhary 2018) (Sreelakshmi *et al.*, 2018).

Hormonal therapy is considered as first - line treatment for AUB and then a combination of hormonal and non – hormonal is advisable. When hormonal therapy is ineffective, then a surgical procedure is advisable (Mullins *et al.*, 2015) (Bradley Gueye 2016). In the present study, 115 prescriptions were given with Hormonal drugs and then followed by combinational therapy in 28 prescriptions. Among hormonal drugs, Norethisterone (Oral progesterone) was most commonly prescribed and Tranexamic acid and Mefenamic acid was most commonly prescribed among non – hormonal drugs and Hysterectomy was the surgical treatment. Similar results were observed in previous studies conducted in Europe among 4506 women stated that Tranexamic acid was commonly prescribed for AUB as non – hormonal treatment (Pados *et al.*, 2011) (Davies Kadir 2017). The above-described studies also stated that (LNG – IUS) was mostly prescribed among hormonal drugs followed by combined hormonal contraceptives (Pados *et al.*, 2011) (Davies Kadir 2017).

In the current study majority of women were having adequate knowledge regarding general menstruation and less knowledge regarding the disease and treatment options available. In the current study, out of 164 respondents, 132 respondents (80.5%) recognized the common age for menarche (which is first menstrual period). 105 participants (69) gave correct response for the frequency of menstruation, 105 participants (64%) given correct response for the normal duration of menstruation. From the above findings it is clear that regarding to the basic terminology the majority of the respondents had adequate knowledge. Similar reports were given in previous studies conducted in Gian sagar medical college and hospital, Punjab on 253 women among the age group of 21 – 60 years and from Raichur (Dt), Karnataka among 100 women age group between 21 to 51 years and above are selected and in Jaipur among 200 women stating that women had good knowledge on the general topic of menstruation (Kaur *et al.*, 2015) (Hooja *et al.*, 2016) (Theresa 2017)

Out of 164 respondents, 12 participants (7.3%) answered correctly about the initial drug of choice for AUB, 49 participants out of 164 (30%) identified that uterine removal was the surgical treatment for AUB and 22 (13.4%) out of 164 stated that hormonal replacement and iron-rich foods can prevent AUB. From this, it was clear that women had very less knowledge on treatment options available for AUB in the present study. Previous studies conducted in Punjab on 253 women among the age group of 21 – 60 years and among 100 women between 21 to 51 years and above from Karnataka and in Mumbai among 200 women between 18 – 55 years and in Jaipur among 200 women also stated that women had very less knowledge on treatment options available for AUB (Kaur *et al.*, 2015) (Hooja *et al.*, 2016) (Bhatiyani *et al.*, 2017) (Theresa 2017).

When it comes to disease, only 24 (14.6%) had idea about heavy bleeding during periods, 124 out of 164 (75.6%) answered correctly that blood clots during vaginal bleeding, 91 (55.5%) identified that vaginal pain, weight gain were the symptoms of AUB, only 18 participants (11%) identified that hot application would relieve vaginal pain and 35 out of 164 (21.3%) answered correctly that heavy work will increase the chance of AUB. Women in the present study had good knowledge on general menstruation and very less knowledge on disease and treatment options available. Previous studies conducted in Punjab among 253 women aged 21 – 60 years and in Karnataka among 100 women aged 21 – 51 years, stated that women had good knowledge on general menstruation and adequate knowledge on the treatment and disease (Kaur *et al.*, 2015) (Theresa 2017). Studies conducted in Mumbai among 200 women having age group of 18-55 years and among 6179 women aged 18-55 years recruited from 15 countries also stated that awareness among women towards the condition and its treatment options was low and knowledge about the risk factors was also very low which is similar to present study results (Singh *et al.*, 2014) (Bhatiyani *et al.*, 2017) To assess the QOL it is the most widely used generic questionnaire. It contains 36 questions in eight health - related categories: Physical Functioning (3 - 12), Role Limitations due to Physical Health (13 - 16), Role Limitation due to emotional problems (17 - 19), Energy/Fatigue (23, 27, 29, and 31), Emotional well - being (24, 25, 26, 28, and 30), Social Functioning (20, 32), Pain (21, 22) and General health (1, 33 - 36). It also includes health change (2) compared to a year ago (Liu *et al.*, 2007) (Karlsson *et al.*, 2014).



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The lower the score of the health - related category the higher the impact of disease on quality of life. The mean score of the all health - related categories was low before the treatment during the hospital visit; Physical Functioning. Role Limitations due to Physical Health (Mean = 39.79), Role Limitation due to emotional problems (Mean = 57.97), Energy/Fatigue (Mean = 57.74), Emotional well – being (Mean = 72.78), Social Functioning (Mean = 72.34), Pain (Mean = 55.61) and General health (Mean = 28.91). There is a significant improvement in the mean scores after 2 months during follow – up; Physical Functioning (90.5-, $p < 0.001$), Role Limitations due to Physical Health (Mean = 77.59), Role Limitation due to emotional problems (Mean = 82.52), Energy/Fatigue (Mean = 76.07), Emotional well – being (Mean = 83.75), Social Functioning (Mean = 89.86), Pain (Mean = 81.92) and General health (Mean = 73.90).

Health change compared to one year ago was also assessed during the initial assessment and in the review assessment it was compared with the present health condition. Comparison of Health change between initial assessment (Mean = 29) and review assessment (Mean = 70) was done. In all the health - related categories of the scale there was a significant improvement, which indicates that treatment of AUB had shown an impact on the improvement of HRQOL in the patients in the present study. A study conducted in Sweden among 1547 women aged 40 – 45 years had shown that women who had decreased SF 36 scores in all the domains were found to have increased scores after medication therapy, which is similar to the present study (Karlsson *et al.*, 2014). A study conducted in UK teaching hospital among 144 women compared both medical and surgical therapy to determine which treatment is superior in improving the quality of life of women with AUB. Women on medical therapy had improved SF – 36 scores for seven of the eight domains after treatment, when compared with surgical treatment, there was much more improvement of health seen in surgical therapy rather than medical therapy (Cooper *et al.*, 2001). Another study conducted in US among 63 women aged 30 – 50 years found that similar improvements in the quality of life were seen in both medical and surgical therapy (Kuppermann *et al.*, 2004). Abnormal uterine bleeding is the major cause that affects the quality of life of women. Many medical treatments are available to improve the quality of life of women. There is a need for the development of educational programs providing the necessary information for the women about the treatment options available for abnormal uterine bleeding, which helps in the improvement of their health – related quality of life.

CONCLUSION

The prevalence of AUB is found to be 2.3% in the study population. Women in the age group of 20 – 40 years are most commonly affected by abnormal uterine bleeding. Ovulatory dysfunction is the most common cause of AUB among functional causes. Leiomyoma is most common cause of AUB among structural causes. Majority of women are having HMB (> 8 days) of bleeding and falls under heavy menstrual bleeding group. Menorrhagia is the most commonly seen symptom, followed by Oligomenorrhea. Hormonal therapy is commonly prescribed than non – hormonal and combinational therapy. Among hormonal mostly prescribed agent is norethisterone and non – hormonal agents are NSAIDs and Mefenamic acid. Women with abnormal uterine bleeding are having lower SF36 scores in all the eight domains before treatment, stating that abnormal uterine bleeding affects women's quality of life. In all the domains of SF36, there is a significant improvement of scores after treatment, mainly in physical functioning, health status and general health. Treatment will increase the quality of life of women with AUB. All patients have good knowledge about general menstruation and inadequate knowledge about treatment and disease.

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Table – 1: Combinational drugs

Combinational drugs	Number of times prescribed	Total Prescriptions	%
Medroxy progesterone acetate & Tranexamic acid	6	28	22
Norethisterone & Tranexamic acid	4	28	14
Norethisterone & Mefenamic acid	3	28	11
Medroxyprogesterone acetate & Iron supplements	3	28	11
Medroxy progesterone acetate & Amcocardial	2	28	7
Norethisterone & Amcocardial	2	28	7
Miscellaneous (single - use drugs)	8	28	28

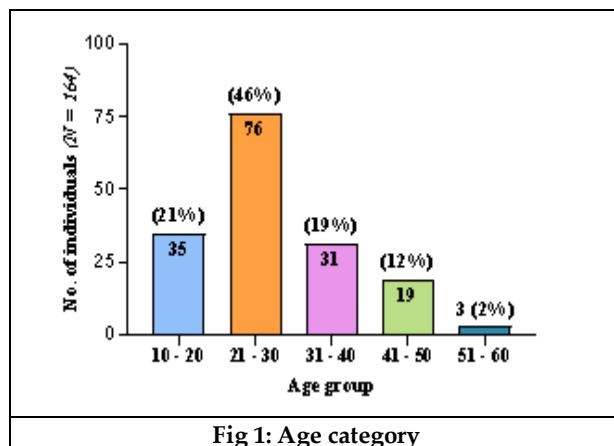


Fig 1: Age category

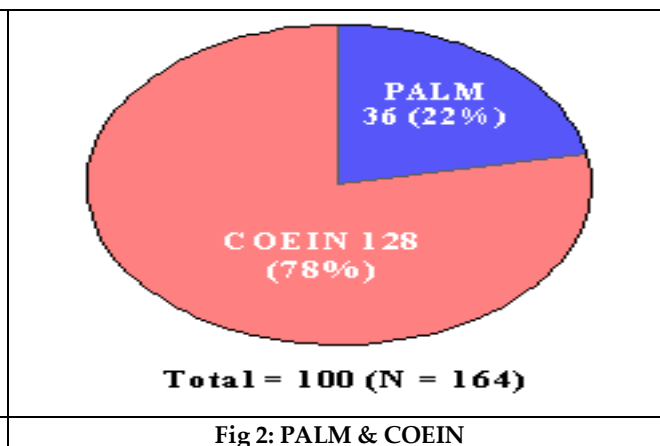


Fig 2: PALM & COEIN





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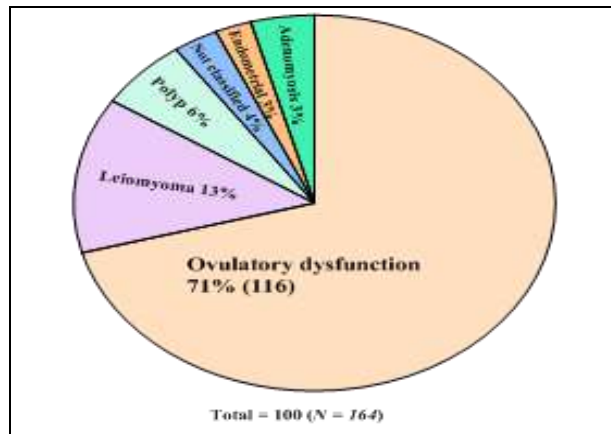


Fig 3: Etiology

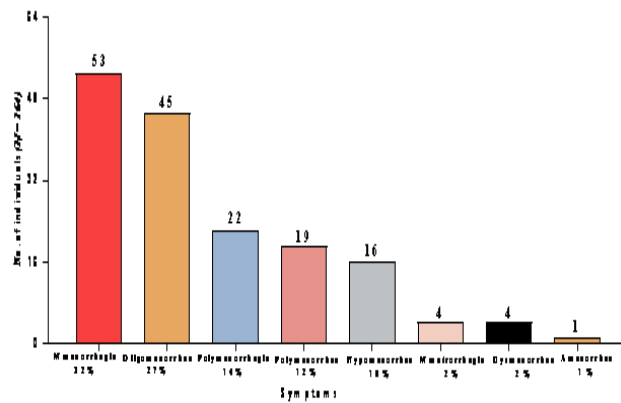


Fig 4: Symptoms of AUB patients

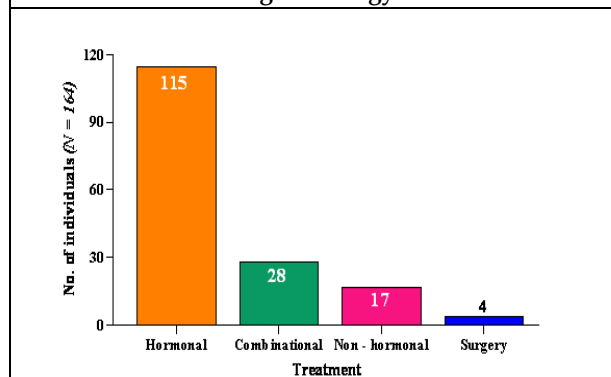


Fig 5: Treatment options

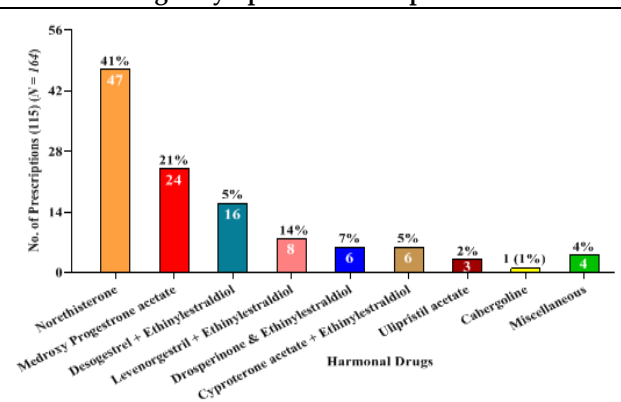


Fig 6: Hormonal drugs

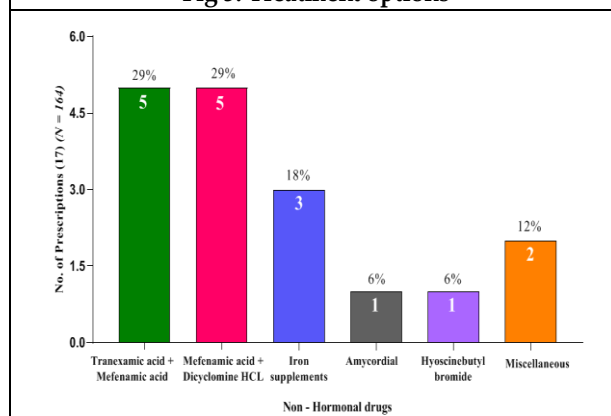


Fig 7: Non – hormonal drugs

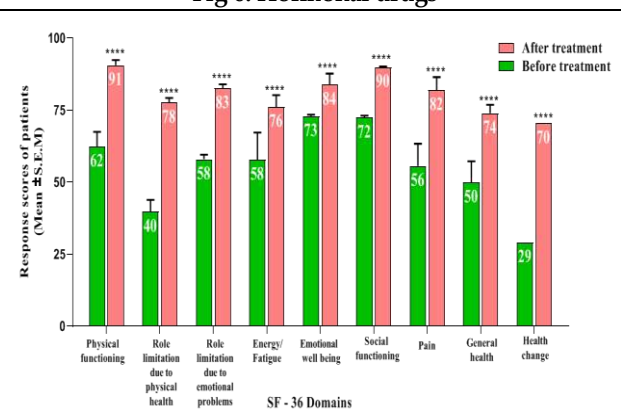
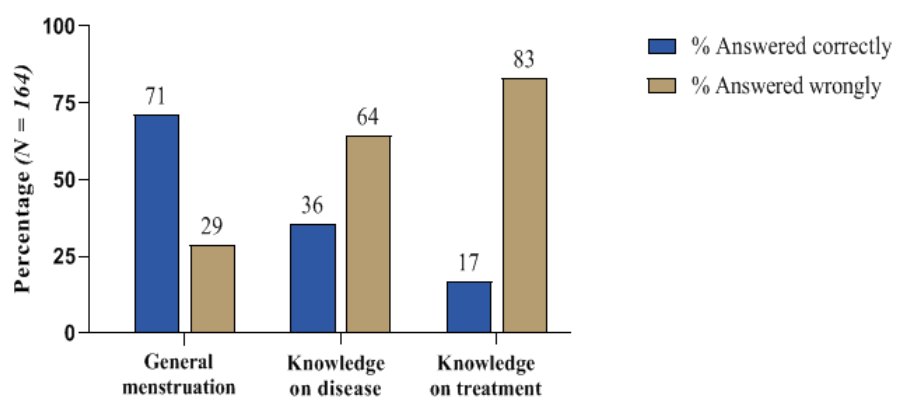


Fig 8: Health assessment means scores



**Kondeti Renusri et al.,****Fig 9: Knowledge assessment**



Mosquitocidal Efficiency of *Bacillus thuringiensis*

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ABSTRACT

Mosquitocidal bacteria are environmentally friendly and alternatives to chemical insecticides for controlling mosquitoes. *Bacillus thuringiensis* isolated from different soil samples as a control strategy of mosquito larvae. This potent isolate were confirmed as *Bacillus thuringiensis* based on microscopic observation and biochemical characterization. The mosquitocidal protein was extracted and it was quantified by Folin Lowry's method. The isolate 10⁻¹ strain showed highest protein concentrations so it was used to check larvicidal activity against mosquito larvae. The mosquitocidal activity (which was measured by mortality rate and change in morphology of larvae) was observed at 10⁻¹, 10⁻³ and 10⁻⁵ dilution factors and interval of every 30 minutes. In control system (distilled water) no mortality was recorded also after 360 minutes. From this study, it is concluded that *Bacillus thuringiensis* is a very potent biolarvicide that brings about mortality of mosquito larvae at short duration of time.

Key words: *Bacillus thuringiensis*, mosquito larva, bioassay, mosquitocidal activity.





INTRODUCTION

Bacillus thuringiensis is an aerobic, Gram positive and spore forming, rod shaped bacteria. It is commonly known as Bt. It is found in soil, water, insect faeces, insects, plant surfaces, etc. It is widely used as a bioinsecticide to control the infestation of caterpillars. Caterpillars eat the spores sprayed onto plants and get killed. *Bacillus thuringiensis* produces an insecticidal protein during sporulation. The *Bacillus thuringiensis* -toxin gene is introduced into plants to develop a variety of pest- resistant plants by genetic engineering. E.g. Bt cotton, Bt corn, etc., The activated Bt -toxin protein produced by *Bacillus thuringiensis* binds to the receptors in the epithelial cells of the midgut of insect larvae and causes swelling and lysis of the cell. Interestingly, *Bacillus thuringiensis* is an important insect pathogen which is highly toxic to mosquito larvae and related dipterans. *Bacillus thuringiensis* is selectively active on pests and less likely to cause resistance hence it is considered beneficial to humans, animals and plants and also as a suitable replacement to chemical pesticides in many countries (Zulfaidah *et al.*, 2013). There are several bacterial species such as *Klebsiella*, *Pseudomonas*, *Rhizobium*, *Caulobacter* and *Azotobacter* are known for enhancing plant growth. *Bacillus thuringiensis*, although known for its insecticidal activity, is also a plant growth- promoting bacterium (Qi *et al.*, 2016). *Bacillus thuringiensis* is sold as dried spores in the market for biocontrol. Vulnerable plants are sprayed by the spore mixture. When the insect larva eats the spores, they reach the gut. In the gut, the *Bacillus thuringiensis*-toxin gets activated leading to the death of the larvae. It kills only the caterpillars of the target insects and other insects and invertebrates are unharmed. This bioinsecticide is used in fruit trees and flowering plants such as the genus *Brassica*.

MATERIALS AND METHODS

Collection of soil sample

A total of four soil samples were gathered from Ambalappattu, Thambikkottai, Vaduvur and Thirumakkottai, belonging to Tanjore and Thiruvavur District, Tamil Nadu respectively. All soil samples were gathered from agricultural lands, between 3 to 5 cm depth. The soil samples were scraped with a sterile spatula and placed in sterile plastic bags. The samples were dried at 40°C during 24 hrs and They were stored at room temperature until analysis. In the same vein, mosquito larvae were gathered from stagnant water.

Analysis of Physiochemical Parameters Determination of pH (Misra, 1968)

In clean conical flask, 20 g of air- dried soil was taken, and 100 ml of distilled water was added for making 1:5 soil suspensions. It was shaken for one hour at regular intervals. After shaking, the suspension was filtered through Whatmann No:1 filter paper. The pH of the sample was determined using a pH meter.

Determination of Temperature (Ahmed *et al.*, 2003)

Temperature probe and the data -collection interface were connected. The temperature probe was inserted into the soil to a depth of 10 cm. When the temperature reading stabilized the displayed value was recorded as the soil temperature at 10 cm below the sample surface.

Isolation of *Bacillus thuringiensis* from soil

Five grams (5g) of each soil sample was gauged and added to 100 ml of distilled water. The samples were warmed on a hot plate for 10 minutes to eliminate all bacteria unequipped of producing endospores. Since it is known that *Bacillus thuringiensis* produces spores, it will be safe to assume that if it was present in the soil, it would be in our warmed sample. The samples were then diluted 5 fold to eliminate all humic materials within the sample and to lessen the overall colony forming units within each sample (Travers *et al.*, 1987).



**Kannahi and Mathumitha****Culturing of *Bacillus thuringiensis***

The diluted sample was cultured on nutrient agar plates for 24 hours at 37 °C in order to allow the spores opportunity to germinate nutrients and optimal temperature. The media, however, offers favourable growth for many microbes as well as *Bacillus thuringiensis*. The colonies were sub-cultured onto Luria - Bertani plates and incubated at 37 °C for 24 hours, so as to obtain pure culture of *Bacillus thuringiensis*.

Identification of *Bacillus thuringiensis*

After incubation, the isolated bacteria were identified by Gram's staining, motility test and biochemical tests using Bergey manual of systematic bacteriology (Bergey, 1957).

Gram's Staining (Hans' Christian Gram, 1884)

A smear of colonies isolated after the identification was made on clean glass slides using a sterile wire loop. They were air dried and fixed. The smears were flooded with crystal violet for around 60 seconds and were washed with tap water. They were then decolourized with Gram's iodine for 30 seconds and then washed with tap water. They were decolourized with acetone and washed off with tap water. The fixed smears were counter stained with safranin and considered 60 seconds and then washed off with tap water and allow to air dry. Oil submersion was added to the stained slides and viewed under a microscopic using x100 objective for the morphological characteristics of the isolates (Oyeleke *et al.*, 2008).

Motility Test (Bailey and Scott, 1966)

Petroleum jelly was applied around the cavity slide. A drop of culture was placed at the center of cavity slide. Then the cover slip was placed over it. The slide was observed under microscope with magnification power of 40X and 100X.

Biochemical Test

The following biochemical test was carried out to find out the enzymatic activities of bacterial culture.

Indole Test

A test tube of sterile peptone water, enriched with 1% tryptophan was inoculated with a young culture of isolates incubated at 37 °C for 48 hrs. Around 4 drops of Kovac's reagent was added and shaken gently. Red colour was occurring immediately at the upper part of the test tube indicating a positive test. A yellow appear at the surface will denote a negative result (Oyeleke *et al.*, 2008).

Catalase Test

The container containing 3% hydrogen peroxide solution was shaken to expel the dissolved oxygen. One drop of the solution was put on a clean glass slide. Presence of gas bubbles shows a positive test while the absence of gas bubbles demonstrates a negative reaction (Cheesbrough, 2002).

Triple Sugar Iron Agar

A bit of the isolate was inoculated by streaking and stabbing into the medium and will be incubated at 37 °C for 24 hours. Fermentation of any of the sugar was demonstrated by a change in colour, from red to yellow and break or raised in the medium indicates gas production (Oyeleke *et al.*, 2008).

Methyl Red Test

A bit of the isolate was inoculated into the medium, which would be incubated at 37 °C for 48 hours. Few drops of methyl red would be added to the culture. Methyl red positive test was a colour while no change denote negative (Oyeleke *et al.*, 2008).



**Kannahi and Mathumitha****Voges-Proskauer Test**

A bit of the isolate will be inoculated into glucose phosphate water medium and incubated at 37 °C for 2 days. Ethanoic solution of 5% α -naphthol (1.2 ml) and 0.4ml potassium hydroxide solution was added to 2 ml of culture and will be shaken vigorously. It will be put in a slanting position (for greatest exposure of the culture to air) and will be examined after 30 to 1 hour. The development of red tone demonstrates a positive test for Voges-Proskauer (Oyeleke *et al.*, 2008).

Urease Test

A bit of each isolate was inoculated into Christensen's urea agar and incubated at 37°C for 24 hours. The freedom of red colour demonstrates urease positive test while the initial yellow tone shows a negative test.

Citrate Utilization Test

A bit of each isolate was inoculated into Simmons's citrate medium and was incubated at 37 °C for 72 hours. Positive citrate is confirmed by the promotion of blue tone while the initial green colour indicates a negative result (Oyeleke *et al.*, 2008).

Antibiotic Sensitivity Test

Bacillus thuringiensis isolates were tested for antibiotics resistance utilizing the standard agar disc diffusion procedure (Bauer *et al.*, 1966) on Mueller - Hinton agar utilizing commercial discs. The antimicrobial agents utilized were ampicillin (10 μ g), penicillin (10 μ g), streptomycin (10 μ g), methicillin (5 μ g), amoxicillin (30 μ g), vancomycin (10 μ g) and chloramphenicol (10 μ g). Antimicrobial breakpoints and translations were taken from the Clinical and Laboratory Standards Institute (CLSI) standards (CLSI, 2007).

Protein Extraction and Estimation

Sterile 30 ml nutrient broth was prepared and 10⁻¹, 10⁻³ and 10⁻⁵ test isolates were inoculated into nutrient broth and incubated at 37 °C for 4 days to induce autolysis. After complete autolysis (after 4 day) 10 ml of the inoculated nutrient broth containing lysed cells were pipetted into centrifuge tube. Crude protein was obtained by centrifugation at 10,000 rpm at 4 °C for 15 minutes. The supernatant was discarded and the pellets were resuspended in 2 ml of sterilized distilled water. The protein concentrations in the crude sample were determined by using the Folin Lowry method with Bovine Serum Albumin (BSA) as a standard (Lowry *et al.*, 1951)

Inoculum Preparation

The great target of inoculum preparation was to accomplish a high level of viable biomass in a reasonable physiological state for use as inoculum. For that 50ml sterile nutrient broth stock was prepared and inoculated with 10 ml suspension of chosen *Bacillus thuringiensis* isolate for the larvicidal explore and incubated at 37 °C for 24hrs.

Biocontrol activity of *Bacillus thuringiensis* against mosquito larvae

Mosquito larvae utilized for the current study was received from the mosquito colony. The bioassay method followed was basically that suggested by the World Health Organization. Bioassay was conducted in beaker. The stock culture of *Bacillus thuringiensis* from conical flask were picked utilizing a sterile pipette and diluted five-fold 10⁻¹, 10⁻³ 10⁻⁵ in sterile distilled water in five tubes. Five (5) ml every one of the cultures in the first, third and fifth test tubes was added to three (3) beaker containing 45 ml of distilled water, providing each beaker with various dilution factors. 25 larvae were transferred into every one of the beaker. The beaker was kept at 25°C-30°C for 360 minutes; the death rate was checked for every dilution factors. A control test was also carried out utilizing distilled water and rainwater. The quantity of live and dead larvae in every beaker was recorded at each 30 minutes and the percentage of larval mortality for each isolate was determined.





RESULTS AND DISCUSSION

Collection of Soil Samples

A total of four soil samples were collected from Ambalappattu, Thambikkottai, Vaduvur and Thirumakkottai, belonging to Tanjore and Thiruvarur, District Tamil Nadu respectively. All soil samples were collected from agricultural lands. The soil samples were scraped with a sterile spatula and placed in sterile plastic bags and subjected to various physicochemical parameters noted in the table 1

Isolation and Identification of *Bacillus thuringiensis*

Serial dilution technique was used to isolate the bacteria. Gram staining, motility test and biochemical tests were used to identify the bacterial species from the soil. The biochemical tests were indole, MR-VP, citrate utilization test, oxidase test, catalase test, Triple sugar ion test were used to identify the bacteria. Luria Bertani agar was used for the isolation of *Bacillus thuringiensis*. The serially diluted soil samples were streaked over the surface of nutrient agar plates and incubated at 37°C for 24-48 hours. After incubation, the white and pale white colour colonies were observed (Kampfer, 1991).

Antibiotics Sensitivity Test

The isolates were shown sensitivity toward the selected antibiotics. In this antibiotic sensitivity test, 90% of resistance was found to amoxicillin, 84% of resistance was found to penicillin. 70% of resistance was found to methicillin. The intermediate level of 52% of resistance was found to vancomycin and ampicillin. Further, 52% of sensitivity was found to streptomycin, and the least percentage of sensitivity was found to chloramphenicol at 8%. In this current study, penicillin resistance has been chosen as one of the indicators for choosing the *Bacillus thuringiensis* from others (Table 2).

Protein Extraction and Estimation

Proteins were recovered from the isolated 3 of *Bacillus thuringiensis* strains and its average recovery yield was recorded as 56%. The most elevated percentage of crystals was observed in the isolate 10^{-1} , 10^{-3} , and 10^{-5} on recovered 63, 51, and 48%, respectively. The samples having high recovery yield were measured by Folin Lowry method and the outcomes demonstrate that the protein present in every one of the samples ranges from 6mg/ml 4 mg/ml and 3 mg/ml. Further, with this recovered protein, larvicidal activity was checked in mosquito larvae (Schnepf *et al.*, 1981).

Bioassay

The outcome for the bioassay of 10^{-1} diluent of *Bacillus thuringiensis* against mosquito larvae. The death rate was found to increase as the incubation time increases. A mortality rate of 52% was recorded after 150 minutes and a 100% mortality rate was recorded after 300 minutes. The bioassay for the 10^{-3} diluents of *Bacillus thuringiensis* on mosquito larvae. The mortality rate of 60% was recorded after 210 minutes, after which a 100% mortality rate recorded after 330 minutes. The bioassay of the 10^{-5} diluents of *Bacillus thuringiensis* against mosquito larvae. The mortality rate of 48% was recorded after 210, after which a mortality rate of 100% was recorded after 330 minutes (Wei, 2003).

SUMMARY AND CONCLUSION

The agricultural soil having the wide range of *Bacillus thuringiensis* population with a lot of potentials. *Bacillus thuringiensis* produce Cry proteins. Among them, *Bacillus thuringiensis* strains 10^{-1} , 10^{-3} and 10^{-5} produced Cry and Cyt related protein, which possess larvicidal activity against the Anopheles mosquito larvae. *Bacillus thuringiensis* had the highest percentages for larval mortality at the highest cell density and the longest exposure time because the toxins were released by the bacteria and accumulated in the mosquito's larvae's digestive tract. *Bacillus thuringiensis*





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is an effective alternative to broad spectrum larvicides in many situations with little or no environmental impact. The results obtained in this study clearly demonstrated the efficiency of the *Bacillus thuringiensis* in controlling mosquito larvae. The use of *Bacillus thuringiensis* as a biocontrol agent against mosquito larva is preferred as it is environmentally friendly and does not deplete the ozone layer unlike the regular pesticides used in killing mosquitoes in most communities. *Bacillus thuringiensis* naturally found in the soil has proved to be a good larvicidal agent against mosquito larvae in the laboratory. The organism and its product can be further studied to search for novel compounds that can be used in the control of mosquito-borne diseases.

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Table 1: Analysis of Physiochemical parameters of soil sample

S.No	PhysiochemicalParameters	Units	Soil	Normalrange
1	pH	-	6.8	06-8
2	Temperature	-	40 °C	-
3	Phosphorus	(mg/kg)	53	0.1
4	Potassium	(mg/kg)	36	0.1
5	Carbon	(mg/kg)	2	-
6	Calcium	(ppm)	1.3	0.5
7	Magnesium	(ppm)	1.02	0.2
8	Nitrogen	(ppm)	36	1.5
9	Iron	(µg/g)	1.2	2-5
10	Copper	(µg/g)	55.2	70-100
11	Zinc	(µg/g)	65.6	70- 100

Table -2: Antibiotic Sensitivity test of *Bacillus thuringiensis*

S.No	Antibiotics	Resistance (%)	Sensitive (%)
1	Amoxicillin	90	10
2	Penicillin	84	16
3	Methicillin	70	30
4	Ampicillin	52	48
5	Vancomycin	52	48
6	Streptomycin	49	52
7	Chloramphenicol	8	92

Table – 3: Bioassay of 10^{-1} diluents of *Bacillus thuringiensis* culture against mosquito larvae

S.No	Time (min)	Control	No. ofLive larvae	No. ofdead larvae	Mortalityrate (%)
1	0	25	25	0	0
2	30	25	24	1	4
3	60	25	21	4	16
4	90	25	18	7	28
5	120	25	15	10	40
6	150	25	12	13	52
7	180	25	10	15	60
8	210	25	8	17	68
9	240	25	5	20	80
10	270	25	3	23	92
11	300	25	1	24	96
12	330	25	0	25	100
13	360	25	0	25	100





A Brief Review Concerning the Structure, Synthesis, and Formation of Dehydroacetic Acid (DHA) and their Metal Complexes

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ABSTRACT

Dehydroacetic acid (DHA), 3-acetyl-4-hydroxy-6-methyl-2H-pyran, is a valuable starting material for synthesizing a wide range of biologically active heterocyclic compounds. Geuther found it in 1866. It is a well-known organic chemistry chemical that exists in five tautomeric forms. DHA combines with various reactants in the presence of multiple reagents to produce a variety of new molecules. It functions as a ligand, forming numerous physiologically significant ligand-metal complexes. It is a biologically active chemical with a wide range of actions. In this paper, we report the structure of DHA, its synthesis, its reactivity, the synthesis of several heterocyclic compounds using DHA, various metal complexes such as Fe, Co, Ni, and Mn, and their various biological relevance.

Keywords: Dehydroacetic acid; Schiff base; biological; tautomeric; heterocyclic.

INTRODUCTION

Dehydroacetic acid (1), commercially abbreviated as DHA, is a monocyclic oxygenated compound derived from pyronewiththe molecular formula $C_8H_8O_4$ [1]. It is isolated from natural sources (Solandra nitida).[2,3] Dehydroacetic acid is mainly employed as a bactericide and fungicide; however, it is also used as a preserver to reduce pickle bloating in strawberries, squash, and other goods. Sodium dehydroacetate, a salt version of Dehydroacetic acid, is





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sometimes utilized. This preservative has good antifungal activity and modest antibacterial effects. It has been observed that DHA and its derivatives have broad usefulness in the field of organic synthesis due to their outstanding chelating ability in current coordination chemistry as well as their reactions. DHA is utilized to produce many items, including skin care products.[4] Sunscreen lotions, fragrances, bath treatments, shaving gels, hair and nail care products, and eye and face cosmetics. It is a colorless to white crystalline powder [5] that is odorless,[6] unstable when heated to breakdown (emitting acrid smoke and unpleasant smells), and sublimates at 109-111°C.[7] Dehydroacetic acid is a weak acid ($pK_a = 5.26$ in water)[8,9], virtually insoluble in water and moderately soluble in most organic solvents.[10]

Structure of DHA

$C_8H_8O_4$ is the molecular formula of over 180 dehydroacetic acid isomers, which can be cyclic or linear (Fig. 1). Because of the wide variety of well-known and essential compounds that can be readily prepared from this acid, determining the correct structure of the isomer of dehydroacetic acid has become very important.

• Schibbye presented one of the first formulas of dehydroacetic acid as a tetraonic cyclooctatetraone (Fig.2).[11] Researchers once showed that dehydroacetic acid is a natural acid with a carboxyl group. This means that the Schibbye form was rejected.

- Oppenheim and Precht[12] presented a formula to express this acidity, but Haitinger [13,14]and Perkin[15] proposed the most satisfactory form of this kind (Fig. 3).
- Because of its very low dissociation constant, Ostwald [27] concluded that it was most likely not a proper acid. He postulated dehydroacetic acid as 2, 4, and 6-trihydroxy acetophenone (Fig.4).
- Based on this theory (that DHA is not an absolute acid), Feist [17] challenged all known formulae and proposed that dehydroacetic acid is an acetylated -lactone (Fig. 5). A few months later, Collie[18, 19]proposed another formula for dehydroacetic acid (6-acetylpyronone), which slightly differs from that of Feist(Fig 6).
- This formula, however, rendered one or two reactions capable of explanation which could not be accounted for by the use of Feist's. It was also based on the assumption that dehydroacetic acid is a lactone.
- Rassweiler and Adams[20] succeeded in elucidating the structural arrangement of Feist's and Collie's compounds in 1924. Their findings supported Feist's structural model while refuting Collie's suggested structure. Dehydroacetic acid (DHA) exists in solid form as acetyl methyl pyridine (2) [21]. DHA in a solution can take any of its five tautomeric conditions, namely (2)-(6)[22], as shown below.

Finally, due to a rapid tautomeric equilibrium between forms (3) and (4), it occurs in two tautomeric forms, namely 3-acetyl-4-hydroxy-6-methyl-2H-pyran-2-one (3a) and 3-acetyl-2-hydroxy-6-methyl-4H-pyran-4-one (3b).

The structure of DHA was fully established later by using the data obtained from spectroscopic analysis^[23-25].

Synthesis of DHA

Geuther(Fig.9) was the scientist [26] who published the first DHA manufacturing process in 1866. It has since been synthesized by cyclizing two equivalents of ethyl acetoacetate in the presence of a condensation agent. The ability of the condensing agent is crucial to the success of the preparation method. Condensing agents often discovered in the literature include $NaHCO_3$ [24-27], $PhONa$ [28], Cu [29], $Pb(OAc)_4$ [30], Ag_2O , BaO , MgO , or amberlite [31], among others. In industry, DHA can be prepared by the dimerization of diketene using catalysts like $NaOAc$ [32], pyridine [33], imidazole [34], $NaOPh$ [35], etc. Another reaction that should be included here is the cycloaddition [4 + 2], or Hetero-Diels Alder reaction, of two acetyl ketenes(7),[36,37] which are prepared from 1,3-dioxanone(8)[38], 1-ethoxybutyn-3-one (9),[38]diacetone oxalyl (10)[39-42] 1,3-oxazine(11)[43] or others,[44-47]to synthesize dehydroacetic acid (Fig. 11)

Reactivity of DHA

The lactone carbonyl at position 2, the carbonyl group of the acetyl side chain at position 3, the carbon atom of the prospective carbonyl group at position 4, and the methyl carbon atom at position 6 are the four potential attack sites for DHA [48](Fig. 12).





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Figure 12 shows that the carbonyl carbon atoms at locations C₂, C₃, C₄, and C₆ are strongly nucleophilic, whereas positions C₃ and C₅ are electrophilic. At the C₄ position, substitution reactions are more advantageous. A distinct cyclization follows the ring's initial opening due to nucleophile attack at positions C₂ and C₆, creating a new heterocyclic structure. With halogenations, the C₅ position is relatively inert. To impart electrophilic or nucleophilic reactivity, the methyl group at position C₆ and the acetyl group at position C₃ are functionalized in distinct ways.

Reaction of carbonyl carbon at C₃ position

Synthesis of Pyrazoles

With piperidine acting as a catalyst, DHA and aromatic aldehydes [50,51] were condensed in CHCl₃ to create the 3-cinnamoyl-2-pyrones (12) (chalcones). At the olefinic link, these chalcones are reduced catalytically [52] to produce the corresponding dihydro derivative, 3 β -arylpropionyl-2-pyrones (13). Upon subsequent condensation with different substituted phenyl hydrazines [53], these dihydro derivatives create physiologically significant pyrazoles (14).

Formylation of DHA: By altering the side chain, the acetyl group of DHA at the C₃ position was formylated [54], and the methyl ether (15) was oxidized to produce 3-formyl-4-methoxy-6-methyl-2-pyrone (16), as shown in Fig. 14

Halogenation: The acetyl group of the DHA at the C₃ position undergoes bromination [55-56] to afford acylbromopyrone (17), and the carbon atom at the C₃ position undergoes bromination to give 3-bromo-pyrone (18) (Fig. 15).

Reaction at C₄ position

Synthesis of Mono and dichloro derivative: on the treatment of DHA with PCl₅ in the presence of ether to give the formation of monochloride (19) while it forms dichloride (20) on treatment with POCl₃ as shown in Fig. 16

Synthesis of Amino pyrones and methyl ether: When DHA reacts with silver oxide's methyl iodide, it produces methyl ethers (23). Conversely, DHA reacts with primary amines [57] and secondary amines when toluene is present, making amino pyrones (24) (Fig. 17). This reaction shows that leaving groups based on oxygen can be displaced when there is a carbonyl group at the C₃ position.

Reaction at C₅ position

Synthesis of Benzhydryl Pyran-2-ones: The activation of DHA's C₅ location in response to an electrophile assault is insufficient. Pyrone (24) is produced when the cobalt (II) complex of DHA (23) combines with benzhydryl bromide. This response includes free radicals and is the exception rather than the rule. [58-59]

Synthesis of Diazo compound: Because the C₅ position of DHA is inert toward electrophiles, it interacts with diazonium cations to produce diazo compounds (25) (Fig. 19).

Reaction at C₆ position

Synthesis of Substituted Compounds of DHA at C₆ Position: The methyl group at C₆, the most nucleophilic carbanionic center, is the site of a regioselective reaction that yields products [60] (26) when DHA is treated with three equivalents of strong base, such as NaNH₂ in liquid ammonia. This produces the corresponding trianion. Alkyl halides, benzophenone, and methyl benzoate were among the electrophiles employed in the reaction that produced the corresponding end products.

Synthesis of Unsaturated Pyrones: Fig. 21 indicates that benzophenone condenses into carbinol pyrone (27) and then unsaturated pyrone (28) upon dehydration.

Formation of metal complexes using DHA:

The most effective chelating agents are DHA and its Schiff bases, and several complexes' general structures (29) have been produced. [61-64]

Formation of Complexes using DHA

DHA and Mn(OAc)₂·4H₂O were mixed in methanol to create Mn(dha)₂(CH₃OH)₂ complexes. Another method of creating Mn(dha)₂(CH₃OH)₂ is to react two equivalents of DHA with Mn (III) acetate in the presence of air [65]. The





Mn (II) is bonded to two oxygen atoms from the coordinated methanol molecules and four oxygen atoms from two DHA ligands. The Mn (dha)₂(CH₃OH)₂ coordination geometry is octahedral, with two methanol molecules filling the two axial sites and with oxygen atoms of DHA ligands occupying the four equatorial positions. From the calculated least-squashminiature lacton ring structure, a planar six-membered ring can be formed by the DHA ligand and Mn (II). The Mn (II) will be in the center of the square plane formed by four oxygen atoms from the two DHA molecules. The position of the two DHA ligands is in the Trans configuration without a significant distortion from the equatorial plane.

Synthesis of Fe (III), CO (II), Ni (II), Mn (II), and Cu (II) complexes by using DHA, 4-Methyl-O-Phenylene Diamine, And Salicylic Aldehyde

Utilizing the asymmetric tetra, dentate Schiff base ligand (30) that is generated from salicylic aldehyde and DHA 4-methyl-o-phenylene diamine, Fe (III), Co (II), Ni (II), Mn (II), and Cu (II) complexes were created [67]. One generates the tetra dentate asymmetric Schiff base in a stepwise manner. The first step involves refluxing DHA and 4-methyl-o-phenylenediamine in dry ethanol for three hours to create a createdevelopono-Schiff base molecule. To prepare the asymmetric ligand, 4-hydroxy-3-(1-[(2-hydroxybenzylidene) amino]-4-methylphenyl) imino) ethyl)-6-methyl-2H-pyran-2-one (H₂L) (30), the resultant mono-Schiff base should be refluxed with salicylic aldehyde. It is necessary to cool the produced asymmetric Schiff base to room temperature before collecting it by filtering and recrystallization in ethanol.

Synthesis of Metal Complexes

A metal chloride methanolic solution should be introduced to a heated ligand methanolic solution while being continuously stirred. 10% alcoholic ammonia solution is added to the reaction mixture to bring its pH down to 7.5–8.5. The mixture is then refluxed until solid complexes start to form. In heated temperatures, the solid stable complexes (31 a, b), (32 a–c) are filtered out. After washing each complex with hot methanol and petroleum ether, the complexes are all dried in vacuum desiccators over anhydrous CaCl₂.

Synthesis of various heterocyclic compounds DHA

Synthesis of thiopyran derivatives

Sulfuric acid reacts with (1) to produce 2,6-dimethyl-4-oxo-4H pyran-3-carboxylic acid (33) following rearrangement. In a combination of diethyl ether and benzene, this novel acid interacted with phosphorus pentachloride (PCl₅) to produce methyl 2,6-dimethyl-4-thioxo-4H-pyran-3-carboxylate (34). After reacting with potassium hydrogen sulfide in aqueous solution in ethanol, the ester produced methyl 2,6-dimethyl-4-thioxo-4H-thiopyran-3-carboxylate (35). [68]

Synthesis of dithiane derivatives:

Dehydroacetic acid undergoes methylation, reduction, dehydration, and oxidation to produce a new aldehyde derivative (36), which transforms into dithianic results) in the presence of dithioacetal (38) (Fig 24).[69]

Synthesis of azetidine derivatives

Upon treating dehydroacetic acid (1) with substituted primary aromatic amines (39a–g), several Schiff bases (40a–g) were produced when the acid was microwave-irradiated. Finally, azetidiazetidinatives (41a–g) are obtained by irradiating these bases with dimethylformamide in the presence of triethylamine and chloroacetyl chloride (Fig. 25, Table 2). In [70]

Synthesis of oxazole derivatives:

Akhrem *et al.* [71] described the synthesis of pyrano-isoxazole (42–43) compounds in methanol by reacting (1) with hydroxylamine. Similarly, Somogyi *et al.* [72] isolate the compound (42) from cleavage of the DHA-acylhydDHA-acyl hydrazone. In the presence of ethanol, enaminone of dehydroacetic acid (44) reacts with hydroxylammonium chloride to produce another oxazole derivative (44).[73] Furthermore, by treating DHA with two moles of hydroxylammonium chloride (Fig. 26), it may be converted to bis-isoxazole (45).[74,75–76]





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CONCLUSION

This systematic review of the literature aimed to present a broad overview of the knowledge regarding the structure of dehydroacetic acid (DHA), the various ways in which it can be synthesized, its higher reactivity towards electrophilic and nucleophilic reagents, the formation of different metal complexes using DHA, and the synthesis of various compounds using DHA.

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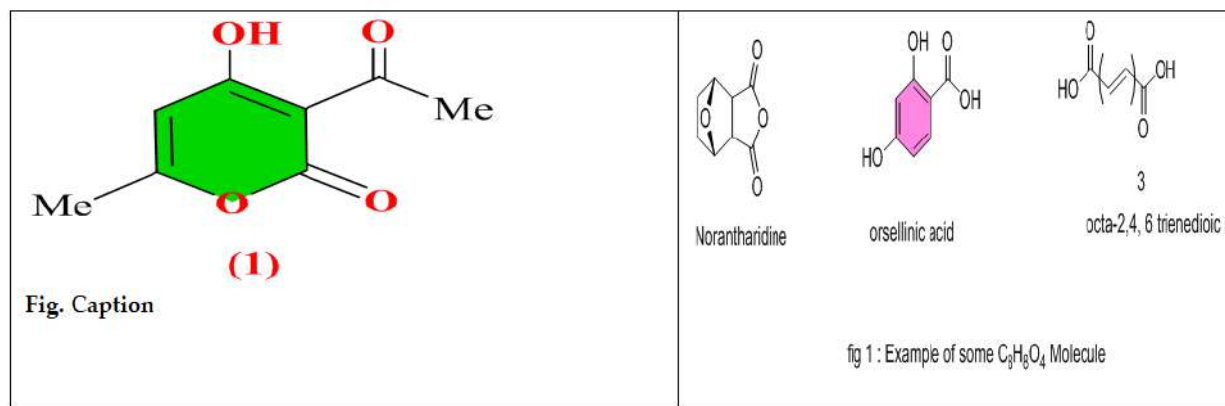


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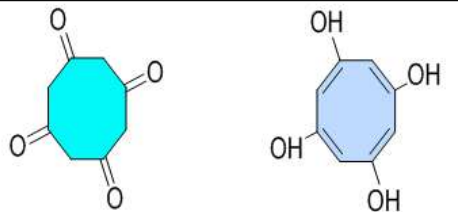

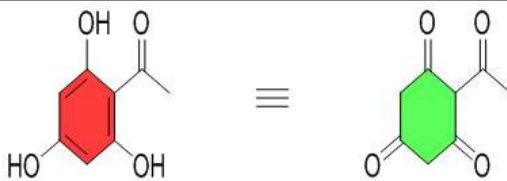

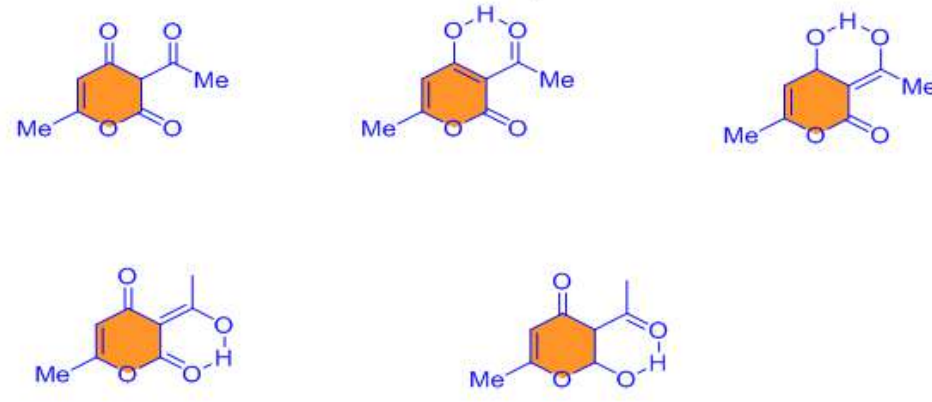

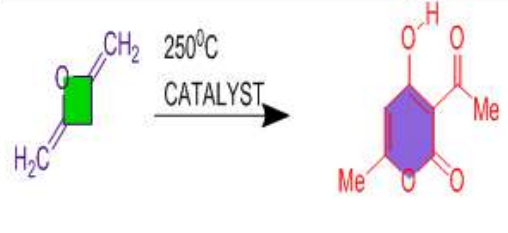
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3	Br	Cl	H	41 c
4	Br	H	H	41 d
5	H	H	H	41 e
6	OH	H	H	41 f
7	H	H	Cl	41 g

Table 2.: synthesis of Azetinone derivative [70]

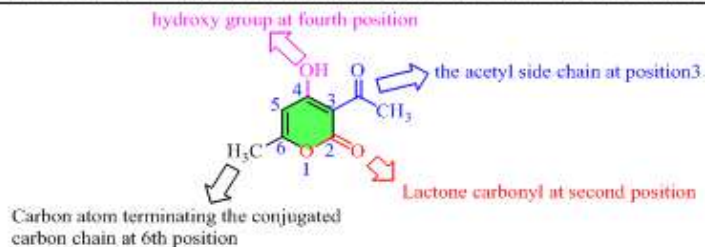
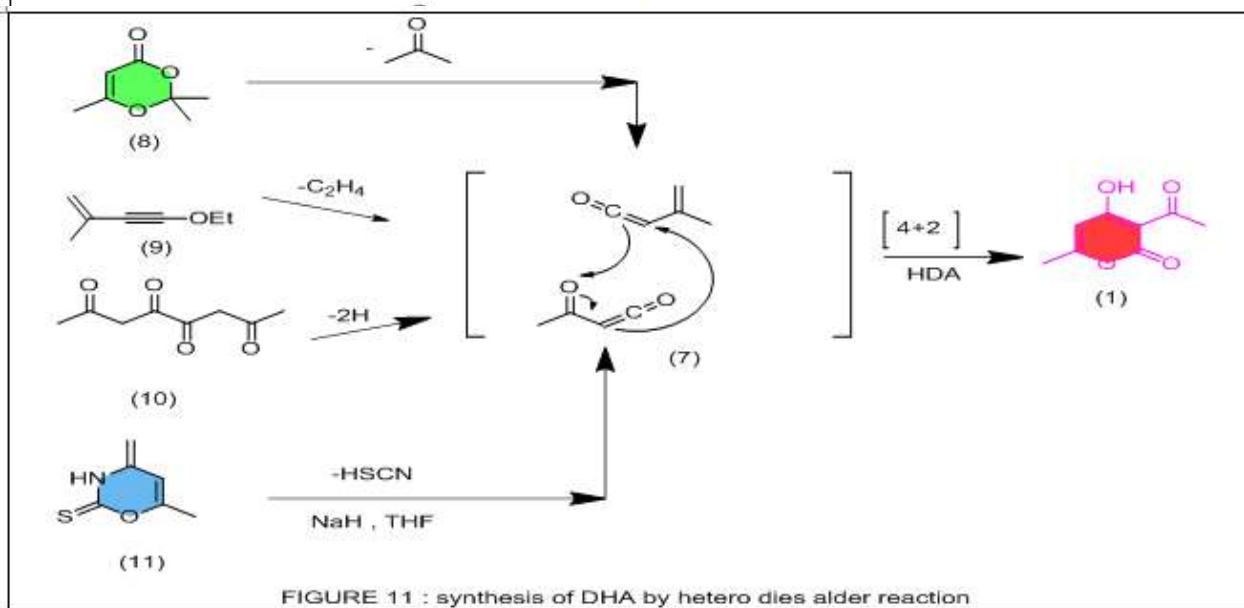
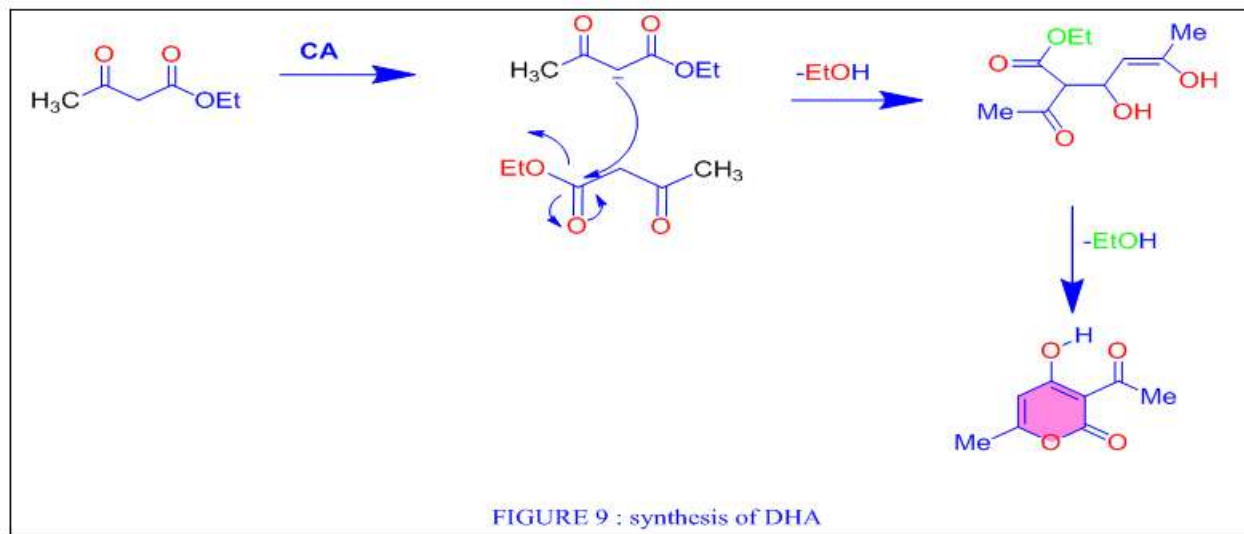




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 <p>FIGURE 2 : Formula proposed by Schibbye reference [11]</p>	 <p>FIGURE 3 : proposed by Oppenheim - Percht reference [12] proposed by Hatiniger and perkin reference [1]</p>
 <p>Figure 4 : formula proposed by ostwald , reference [16]</p>	 <p>FIG: Formula proposed by Feist reference [17] FIG 6: Formula proposed by Collie reference</p>
 <p>Figure 7 : Show five tautomeric forms , reference [22]</p>	
 <p>Fig : 8 tautomerism form of DHA</p>	 <p>FIGURE 10 : formation of DHA from ketene</p>



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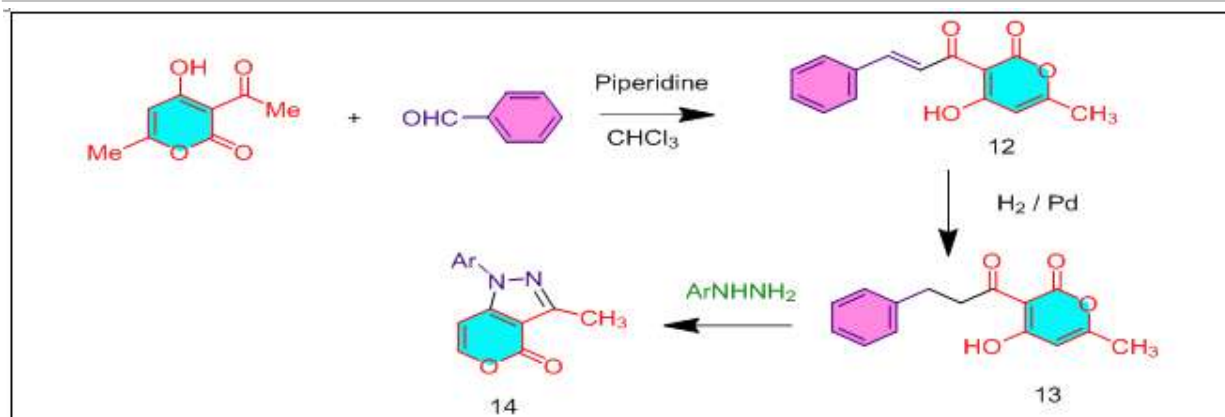
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FIGURE 13. Synthesis of pyrazoles ,reference [50-53]

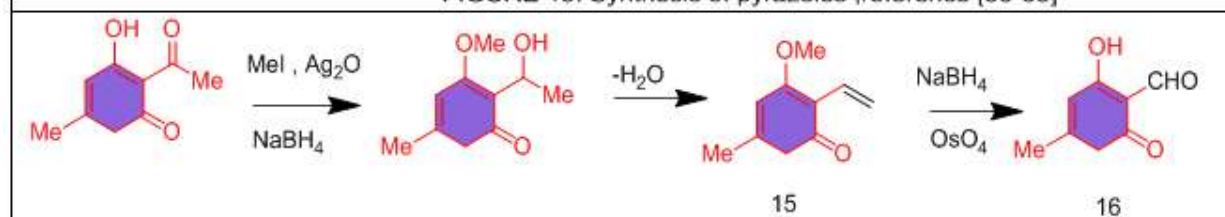


figure 14 . formylation of DHA , reference[54]

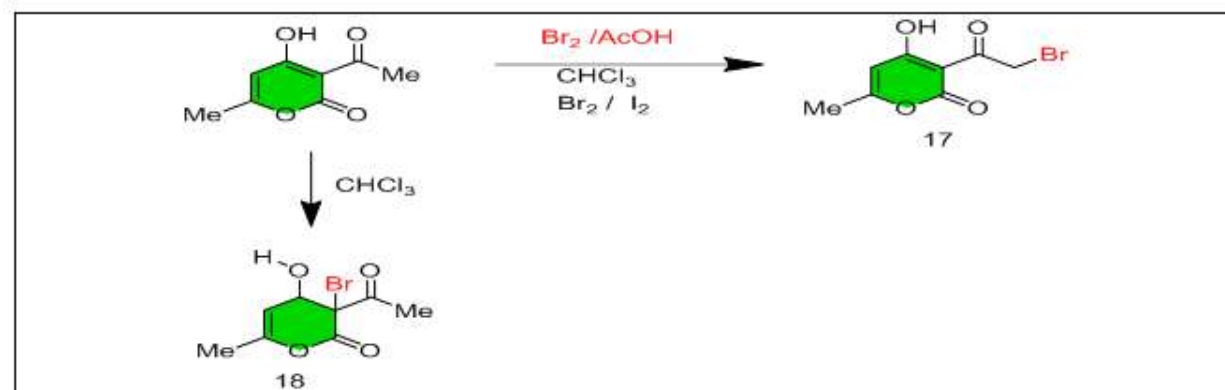


fig 15. halogenation of DHA , Reference [55-56]

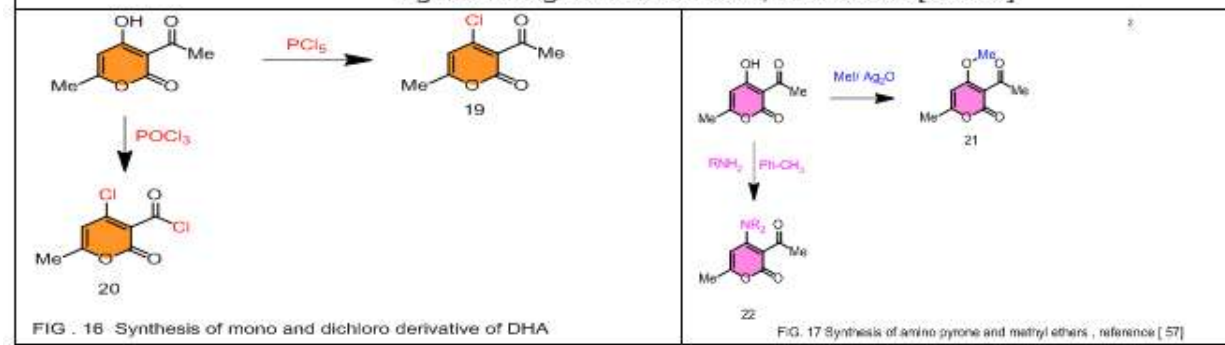


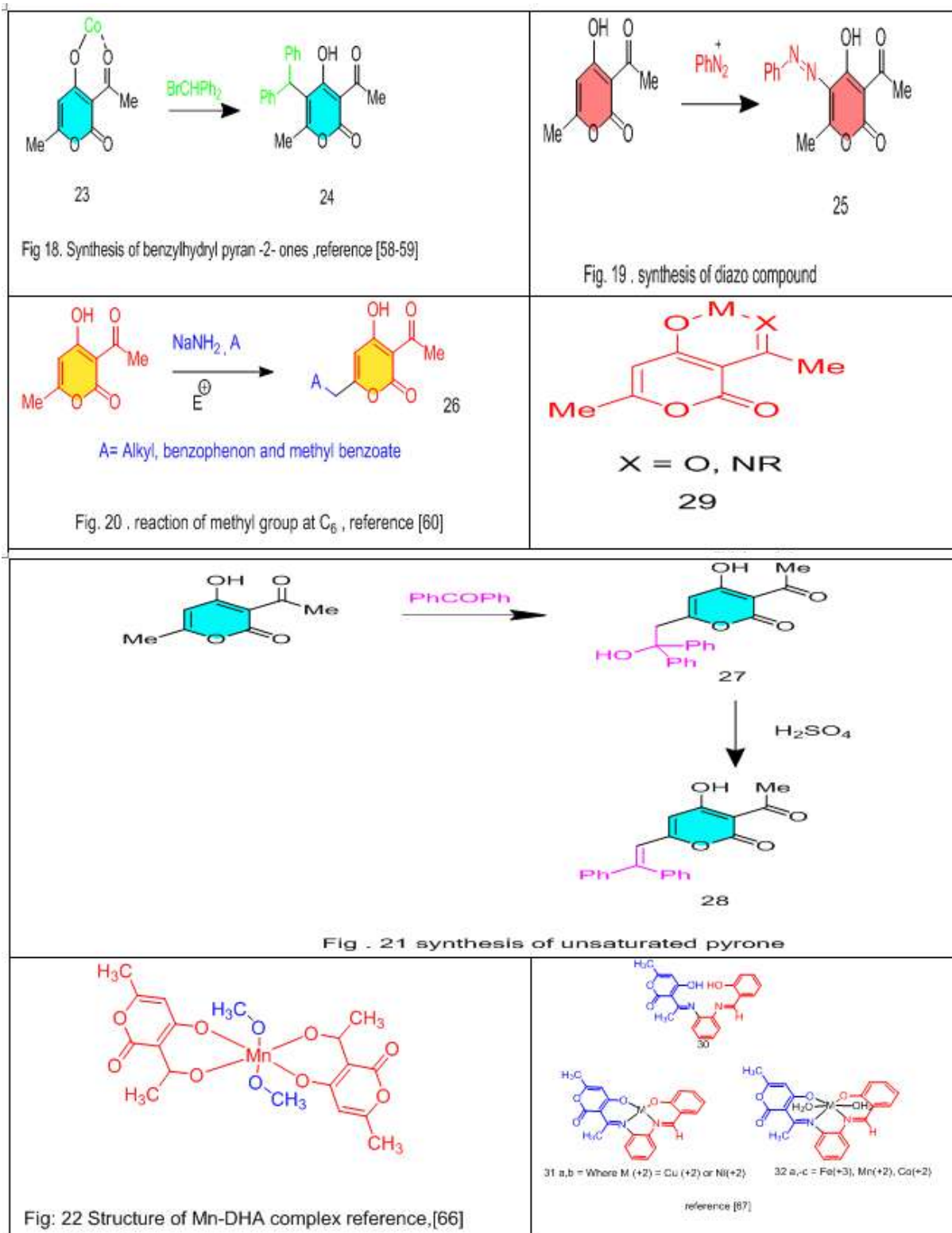
FIG . 16 Synthesis of mono and dichloro derivative of DHA

FIG. 17 Synthesis of amino pyrone and methyl ethers , reference [57]





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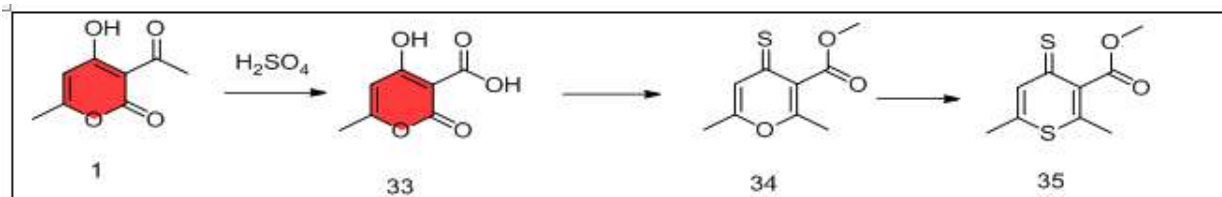


fig . 23 Reference [68]

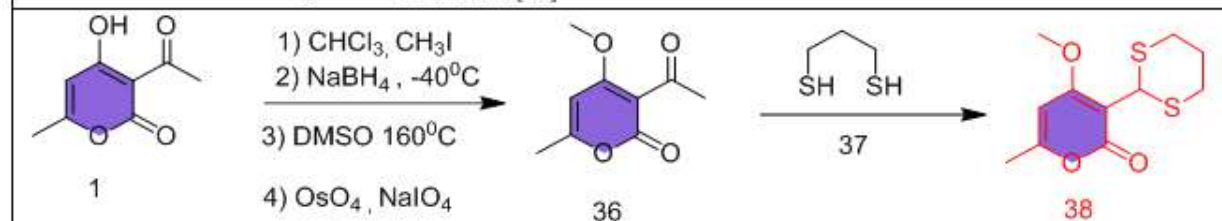


Fig: 24 reference [69]

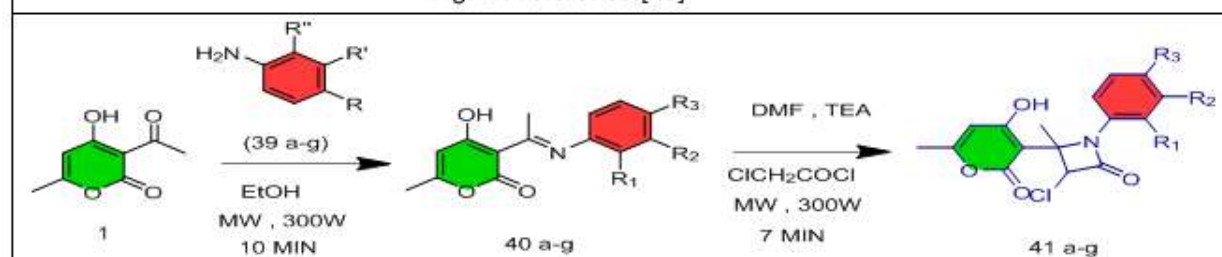


FIG 25 ,Reference [70]

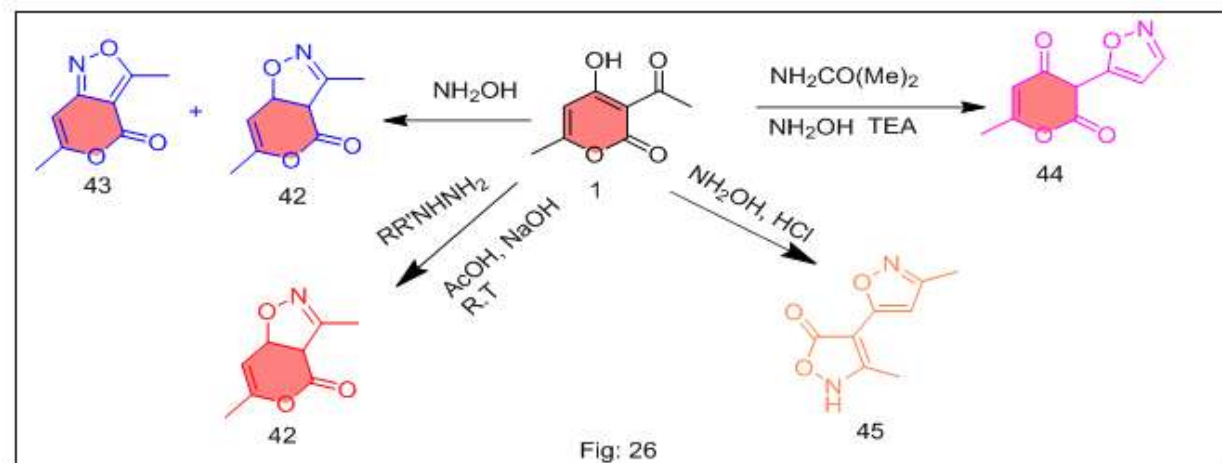


Fig: 26





RESEARCH ARTICLE

Evaluating Anti-Diabetic Effect of the Formulation Puliyaathi Choornam (PC) against Streptozotocin (STZ) Induced Diabetes in Wistar Albino Rats

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ABSTRACT

Siddha medicine is a traditional medical system in South India and has been practiced for thousands of years. The formulation Puliyaathi chooranam in ancient text Siddha VaidyaThirattu has been indicated for diabetes and found potential against Type II diabetes by the observations and experiences of Siddha practitioners. Diabetes was induced in male Wistar albino rats by Injecting Streptozotocin 50mg/kg body weight was evaluated for its anti-diabetic effect. Injecting Streptozotocin. Then the animals were treated with standard drug and Puliyaathi Choornam 200mg/kg (200 and 400 mg/kg) till 28 days. The anti-diabetic activity was examined by estimating Fasting blood glucose levels was measured on 0th, 7th, 14th, 21st and 28th day of the treatment period before the administration of extracts. The blood glucose level were near to normal levels after 28 days of treatment at 400 mg/kg. The 400 mg/kg dose shows higher anti-diabetic effect compared to the lower 200 mg/kg dose. From the result, it is concluded Puliyaathi Choornam has valuable source of active compounds with anti-diabetic properties and can be used to treat diabetes.

Keywords: Puliyaathi Choornam, Wistar albino rats, phytochemical analysis, Blood glucose level, Streptomycin.





INTRODUCTION

Diabetes mellitus, an enduring metabolic ailment afflicting a vast multitude of individuals across the globe, presents a formidable worldwide health predicament [1]. The management of this condition necessitates ongoing treatment to regulate blood glucose levels and avert complications [2]. The prevalence of diabetes worldwide is predicted to rise from 9.3% (463 million) in 2019 to 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045. Urban areas have a higher prevalence (10.8%) compared to rural areas (7.2%), and high-income countries have a higher prevalence (10.4%) compared to low-income countries (4.0%) [3]. Siddha medicine, an ancient traditional healing system indigenous to South India with a rich historical lineage spanning millennia, offers a comprehensive approach to healthcare encompassing herbal concoctions, lifestyle adjustments, and therapeutic interventions [4]. The complex herbal concoction known as "Puliyathi Chooranam" in the ancient Siddha system of medicine consists of a carefully curated blend of botanical constituents. This formulation incorporates the following ingredients: Puliyamarapattai (*Tamarindus indica*.L.), Puliyangottai maelthol (*Tamarindus indica*.L.), and Seenthilthandu (*Tinospora cordifolia*. Willd), all of which have been traditionally recognized for their therapeutic efficacy in managing the metabolic disorder known as diabetes mellitus [5]. *Tamarindus indica* L., commonly known as the Tamarind tree, is a unique member of the Caesalpinioideae subfamily within the Leguminosae (Fabaceae) family.

It holds a prominent position as a versatile tropical fruit tree species in the Indian subcontinent. This remarkable plant boasts a plethora of chemical compounds, making it rich in phytochemicals. Consequently, *Tamarindus indica* L. has been documented to exhibit significant potential in terms of its antidiabetic properties [6]. *Tinospora cordifolia* Willd, a herbaceous vine belonging to the Menispermaceae family, is native to tropical regions of the Indian subcontinent. The stem of *Tinospora cordifolia* Willd, commonly referred to as TC, has long been utilized in traditional folk medicine in India for treating diabetes. A fraction abundant in isoquinoline alkaloids (referred to as AFTC) derived from the TC stem, along with three specific alkaloids—palmatine, jatrorrhizine, and magnoflorine—were subjected to have potential to mimic insulin and stimulate insulin release [7]. Within the realm of Siddha medicine lies a wealth of knowledge pertaining to the utilization of medicinal plants and natural constituents for the treatment of diabetes. In recent decades, diligent research efforts have persisted in quest of efficacious naturally occurring anti-diabetic agents capable of counteracting the life-threatening consequences of diabetes [8]. The primary advantage of employing naturally derived herbal remedies and botanical sources in the healing process is the attainment of prolonged efficacy coupled with diminished adverse effects [9]. Consequently, there exists a compelling impetus to unearth novel therapeutic entities for addressing the afflictions of diabetes. Thus, this investigation endeavors to explore the potential of such natural remedies for managing type II diabetes. Within the domain of traditional medicine, Puliyathi chooranam has been ascribed various applications. However, its potential anti-diabetic properties remain unexplored. Consequently, the present study endeavors to assess the anti-diabetic effect of Puliyathi chooranam.

MATERIALS AND METHODS

Materials

The animal model Wistar albino rats are purchased from the animal house of Mass biotech Chennai, India for the experimental study. The animals were kept in the ventilated room under normal laboratory condition with food and water and libitum. The animals were acclimatized 2 weeks before they were exposed to the experiment. Streptozotocin is bought from Sisco Pharmaceuticals. Materials STZ, Glibenclamide was purchased from TCI Chemicals (India) Pvt. Ltd Limited, Mumbai.

Methodology

Plant Collection and Authentication

The drugs included in the formulation were purchased from well reputed shop at Broadway and the raw drug was authenticated by the Medical Botanist of Government Siddha medical college. (Authentication No: 02/2022 Botany)



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on date 29th January 2022. The medicine is prepared in Gunapadam laboratory at Government Siddha medical college.

Experimental Animal Approval

All animal experiments were performed in accordance with the Guidelines of OECD. All experiments were performed with the approval of Institutional Animal Ethics Committee (IAEC) of C.L. Baid Metha college of pharmacy, Chennai-47, Department of pharmacology during the academic year of 2022-2023 (IEAC No:012/31/PO/Re/S/01/CPCSEA/dated 12/07/2022)

Preparation of the extract

The extract was prepared by measuring 5 grams of PC sample and placing it into a clean 250 ml beaker. Then, 50 ml of distilled water was added to the beaker. The mixture was vigorously boiled and subsequently allowed to cool down. Once cooled, it was filtered into a 100 ml volumetric flask. Distilled water was added to make up the total volume to 100 ml.

Phytochemical Screening of Puliyathi chooranam:

The extracts of Puliyathi chooranam was used for preliminary phytochemical screening for the detection of alkaloid, coumarins, tannin, saponins, glycosides, flavonoid, phenols, steroids, tri terpenoid, Cyanins (Anthocyanin), Carbohydrates, protein by using various phytochemical tests.

Induction of Diabetes

The animal model for this activity is the Wistar albino rat of either sex. The weight of the animals range from 220-400gm. The Diabetes is induced to the animal model Wistar albino rat by Injecting Streptozotocin. It is injected as intra peritoneal at the dose of 50mg/kg bodyweight. Streptozotocin was dissolved in 0.1M sodium citrate buffer (pH - 4.5) and this solution was injected. All the animals were randomly selected before the administration of the Streptozotocin injection and food was withdrawn overnight but water ad libitum. After the injection, all rats were access free to food and water. The animals were allowed to drink 5% glucose solution overnight to avoid hypoglycemic shock. After 48 hours of Streptozotocin injection, the animals having fasting blood glucose level more than 200mg/dl were considered as diabetic rats and used for the experimentation. The animals were divided into 5 groups each constituting 6 rats. Group I were normal rats, Group II were STZ (55 mg/kg b.w., i.p) induced diabetic rats. Group III STZ (55 mg/kg b.w., i.p) induced diabetic rats were treated with Glibenclamide 5mg/kg b.w/p.o. Group IV STZ (55 mg/kg b.w., i.p) induced diabetic rats were treated with Puliyathi Chooranam 200mg/kg b.w/p.o. Group V STZ (55 mg/kg b.w., i.p) induced diabetic rats were treated with Puliyathi Chooranam 400mg/kg b.w/p.o. for 28 days. It is shown in the (Table 1) Fasting blood glucose levels was measured before the administration of extracts. The blood glucose levels were checked on 0th, 7th, 14th, and 21st day of the treatment period. Blood was collected from snipping of the rat tail. Blood glucose levels were measured

Histopathological Study

For the histopathological analysis, a sample of pancreatic tissue was carefully extracted and preserved in 10% buffered neutral formal saline solution. Following fixation, the tissues were embedded in paraffin. Slices of the fixed tissues, approximately 5 µm thick, were prepared and subjected to staining using hematoxylin and eosin. Subsequently, the stained tissue sections were observed under a light microscope, and photomicrographs were captured for further analysis

Statistical Analysis

All the values were expressed as Mean ± S.D. The differences between Control and treatment groups were tested for significance using ANOVA followed by Dunnett's test. P < 0.05 were considered significant.



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RESULTS

Phytochemical Screening

The Phyto-chemicals screening of the extract gives general idea regarding the nature of chemical constituents present in the crude drug. These Phyto-constituents work with nutrients and fibers to form an integrated part of defense system against various disease and stress condition. The PC was subjected to the following phytochemical screening based on the method illustrated in BrainKR, TurnerTD. The Practical Evaluation of Different phytochemical constituents were present in the extract of puliyathi chooranam (Table 2).

Blood Glucose level

The effect of Puliyathi chooranam in STZ induced diabetic rats was analyzed on 0th, 7th, 14th, 21st day and 28th day of the treatment period. The result of Blood glucose level in all the experimental groups were not significant with each other on 0th, 7th, 14th, 21st day. Administration of Puliyathichooranam at high dose of 400 mg/kg body weight caused a significant dose-dependent decrease in blood glucose level as compared with the control group (Table 3). Each value represents Mean \pm Standard Error of Mean (S.E.M) (n=6). The statistical analysis was performed using one way Analysis of variance followed by Dunnett's multiple comparison test. *p < 0.05 as compared to normal.

Histopathological findings of Pancreas

Figure 2 A shows Control group of normal structure of the pancreas. The exocrine component forms of pancreas closely packed by acinar cells and arranged into small lobules. Figure 2B Diabetic group reveals pathological changes of both exocrine and endocrine cells. The acinar cells are swollen with small vacuoles. Islet β -cells entirely lost in STZ-treated. Figure 2C Normal structure of Islets of Langerhans. Atrophic change of the acinar cells is less severe. Figure 2D Low dose shows distortion of the general architecture exocrine acini reveals acinar damage shown by cytoplasmic vacuolation and cell atrophy. Figure 2E, Drug treated shows regeneration of islets, small vacuoles in the basal area of acinar cells is also much smaller. Control group showing normal structure of the pancreas. The exocrine component forms of pancreas closely packed by acinar cells and arranged into small lobules. Diabetic group reveals pathological changes of both exocrine and endocrine cells. The acinar cells are swollen with small vacuoles. Islet β -cells entirely lost in STZ-treated. Normal structure of Islets of Langerhans. Atrophic change of the acinar cells is less severe. Low dose shows distortion of the general architecture exocrine acini reveals acinar damage shown by cytoplasmic vacuolation and cell atrophy.

DISCUSSION

Diabetes mellitus, a chronic pathological state with a staggering global prevalence, arises from insufficient endogenous insulin production or impaired insulin utilization within the body [10]. Consequently, hyperglycemia ensues, instigating a panoply of complex complications that reverberate across diverse bodily organs and systems [11]. The pursuit of alternative treatments for diabetes stems from several factors [12]. Firstly, despite significant advancements in medical research, diabetes continues to pose a significant challenge, with rising prevalence rates and associated healthcare costs [13]. Secondly, some individuals experience difficulties in adhering to conventional treatments due to factors such as medication side effects, lifestyle restrictions, or personal preferences [14]. Additionally, the limitations of current treatments, such as the inability to restore normal pancreatic function or achieve optimal glucose control, have prompted the exploration of alternative avenues [15]. According to the classical Siddha literature "Mega Nivarana Bodini Ennum Neerizhivu Maruthuvam" polyherbal formulation "Puliyathi Chooranam" was indicated for Neerizhivu (Diabetes Mellitus). Various studies suggest that individual ingredients of the formulation Puliyathi Chooranam i.e Puliyamarapattai (*Tamarindus indica.L*), Puliyangottai maelthol (*Tamarindus indica.L*) Seenthil thandu (*Tinospora cardifolia.WILLD*) possess anti-diabetic potential [5]. In the group supplemented with the aqueous extract of *Tamarindus indica.L* (tamarind), there was a significant reduction in the activities of liver glucose-6-phosphatase, as well as liver and kidney glutamate oxaloacetate transaminase (GOT)



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and glutamate pyruvate transaminase (GPT), compared to the diabetic group. These findings suggest that the tamarind extract may have beneficial effects on glucose metabolism and liver and kidney function in diabetes [16]. The comprehensive analysis of *Tinospora cordifolia*.WILLD conducted in this study unveiled a rich assortment of bioactive phenolic compounds. These findings suggest that the robust antidiabetic properties of *T. cordifolia*.WILLD could be attributed to the presence of compounds capable of inhibiting the enzymes α -amylase and α -glucosidase [17]. The research revealed that the aqueous extract of *Tamarindus indica*.L, contains various bioactive compounds such as alkaloids, saponins, tannins, flavonoids, terpenoids, quinones, glycosides, and phenols. These compounds possess notable medicinal properties and show promising potential in terms of their anti-diabetic effects. As a result, the study provides supporting evidence for the traditional claims made by Siddha practitioners regarding the effectiveness of Puliyaathi Chooranam in the management of diabetes [18]. Various in vivo and in vitro studies have employed different models to investigate diabetes. These include the use of Alloxan induction, high-fat diet (HFD) induction but Wistar rats are genetically susceptible strains [19]. Streptomycin-induced rat models are unique because they provide a controlled and reproducible experimental system to study the effects of antidiabetic interventions. Streptomycin administration allows for the induction of diabetes in rats, mimicking the pathophysiological characteristics observed in human diabetes.

This model enables researchers to investigate the efficacy of potential antidiabetic agents, evaluate their mechanisms of action, and assess their safety and therapeutic potential [20]. The use of Streptozotocin-induced (STZ) diabetic rat models is a well-established method for evaluating the anti-diabetic activity of various compounds. The study demonstrated that a single dose of 50 mg/kg STZ was capable to induce pancreatic β -cell destruction in rats [21]. However, the present study supports the fact that Puliyaathi chooranam rebuilt the destroyed islet and acini cells enabling them to perform their responsibilities. It was noticed that high dose (400mg/kg) treatment involved in the process of islet regeneration and the presence of small vacuoles in the basal area of acinar cells. More important, blood glucose levels had markedly decreased in DAE rats. The healing enhancing effect on the acini and β -cell were perhaps responsible in part, for the antidiabetic properties of Puliyaathi chooranam. The results were similar with the study Syimai, Nur et al. [22]. It is important to acknowledge that animal models have one of the limitations representing human physiology and disease progression. Hence, conducting clinical trials on human subjects is imperative to validate the findings and ascertain the safety and effectiveness of Puliyaathi Chooranam as a treatment for diabetes in humans. Despite these limitations, the results of this study provide a foundation for further research into the active components and mechanisms of action of Puliyaathi Chooranam. Identifying these bioactive compounds could lead to the development of novel anti-diabetic drugs or the refinement of traditional Siddha treatments for diabetes management. By understanding these changes at a microscopic level (histopathology), researchers and healthcare professionals can better comprehend the underlying mechanisms of the disease and develop targeted treatment strategies

CONCLUSION

In conclusion, this study demonstrates that Puliyaathi Chooranam, as mentioned in the Siddha text exhibits significant anti-diabetic potential in a Streptozotocin-induced diabetic rat model. The formulation's ability to restore blood glucose levels towards normal values suggests its usefulness as a potential treatment for Type II diabetes.

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Table 1: Groups and Treatment

Groups	Treatment
Group I	Normal Control
Group II	Diabetic control- STZ (55 mg/kg)
Group III	Diabetic control- glibenclamide (5 mg/kg)
Group IV	Diabetic control- Puliyathi Chooranam 200mg/kg
Group V	Diabetic control- Puliyathi Chooranam 400mg/kg

Table 2: Phytochemical screening of extract of puliyathi chooranam

Preliminary Phytochemical Constituents	PC(puliyathi chooranam) extract
Alkaloid	+
Coumarins	+
Tannin	+
Saponins	+
Glycosides	+
Flavonoid	+
Phenols	+
Steroids	+
Tri terpenoid	+
Anthocyanin	+
Carbohydrates	+
Protein	+

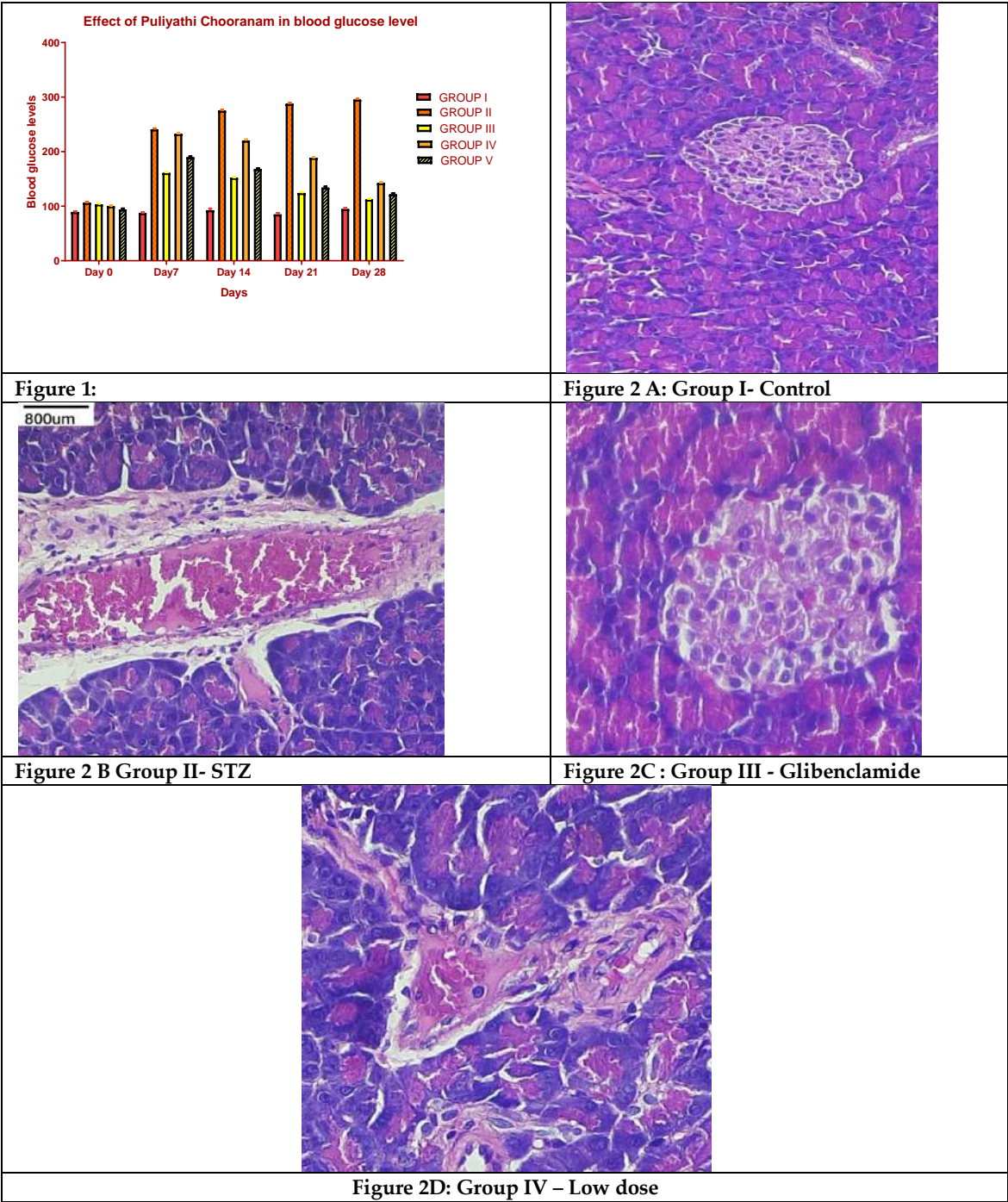
Table 3: Effect of Puliyathi Chooranam in blood glucose level

Group	Blood glucose (mg/dl)				
	Day – 0	Day – 7	Day – 14	Day – 21	Day – 28
I	89.40±1.30	87.53±1.38	92.75±2.86	85.13±2.46	94.70±2.18
II	106.22±1.42	240.9±1.62	275.3±1.46	287.8±1.30	295.4±1.21
III	103.5±1.46	161.0±1.34	152.05±1.31	124.2±1.43	112.3±1.46
IV	100.13±1.22	232.5±1.05	220.2±2.17	188.8±1.20	142.5±1.44
V	94.23±1.38	189.8±1.34	168.04±1.28	134.03±1.70	120.8±1.83





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Interval Valued Kernel Symmetric, k-kernel Symmetric, Range Symmetric and Column Symmetric Intuitionistic Fuzzy Matrices

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ABSTRACT

We present the range-symmetric, interval-valued Intuitionistic fuzzy matrix (RS-IVNFM) and the kernel-symmetric, interval-valued Intuitionistic fuzzy matrix (KS-IVIFM), which is similar to the EP-matrixes in the unitary domain. We first present equivalent characterizations for an RS matrix. Then, we derive equivalent conditions that an IVIFM is a KS matrix, and finally, we study the relationship between RS-IVIFM and KS-IVIFM. With suitable examples, we introduce the idea of k-KS and RS-IVIFM. We introduce some primary results about KS matrices. We demonstrate that KS implies k-KS, but the converse need not apply. Numerical results explain the equivalent relationships between KS, Moore-Penrose inversion of IVIFM and k-KS.

Keywords: IVIFM, RS-IVIFM, KS-IVIFM, k- KS-IVIFM

INTRODUCTION

Zadeh [1] first introduced fuzzy sets (FSs) in 1965. These are traditionally defined by their membership value or grade of membership. Assigning membership values to a fuzzy set can sometimes be challenging. Atanassov [2] introduced intuitionistic FSs to solve the problem of assigning non-membership values. Wang et al., [4] and [5] generalized the concept of NSs to single valued NSs and interval-valued NSs to overcome the difficulties faced during application of NS values in real-life. Smarandache [3] introduced the concept of neutrosophic sets (NSs) to handle indeterminate information and deal with problems that involve imprecision, uncertainty, and inconsistency. If fuzzy matrices P and P^+ have a positive counterpart (P^+), then the two coincide with P 's transpose. Kim and Roush





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[6] studied generalized fuzzy matrixes and found that a fuzzy P matrix is symmetric when the range P equals the transpose range, P^T . It is also kernel symmetric when the null space of P equals the null space of P^T . It is widely accepted that range and kernel symmetry concepts are equivalent in matrices. The range symmetry of neutrosophic fuzzy matrices is $R[P]=R[P^T]$, but not the kernel symmetry $N(P)=N(P^T)$. Meenakshi [7] introduced fuzzy matrices by introducing k , a fixed product derived from disjoint transformations. Hill and Waters [8] discussed on k real and k hermitian matrixes. Baskett and Katz [9] explored the concepts on EPr matrixes. Schwerdtfeger [10] delved deep into linear algebra and matrices. Meenakshi, Jayashri [11] have discussed k -KS Matrices. Riyaz Ahmed Padder [12-14] studied idempotent intuitionistic fuzzy matrices of the T-type. They also explored the reduction of non-nilpotent IFMs by using implication operators and determinant theories for IFMs. Atanassov [15] on the other hand, focused on generalized index matrixes. Sumathi and Arockiarani [16] briefed on new operations on fuzzy neutrosophic soft matrices. Meenakshi and Krishnamoorthy [17] presented k -EP matrixes.

RESEARCH GAP

Anandhkumar et al., [18] presented the concept of range and kernel-symmetry principles to NFM. We have applied the range and kernel-symmetry principles to IVIFM in this context. We have examined some of the results and extended both concepts to IVIFMs. We first present equivalent characterizations for a RS matrix and a KS matrix. We then derive the equivalent conditions that IVIFMs must meet to show kernel symmetry, and we explore the relationship between range symmetry and kernel symmetry. We also find equivalent conditions that allow various generalized inverses to have kernel symmetry.

PRELIMINARIES AND NOTATIONS

PRELIMINARIES

If $\kappa(y)=(y_{k[1]}, y_{k[2]}, y_{k[3]}, \dots, y_{k[n]}) \in F_{n \times 1}$ for $y = y_1, y_2, \dots, y_n \in F_{[1 \times n]}$, where K is involuntary, The corresponding Permutation matrix is satisfied using the following

$$(P_1) K = K^T, K^2 = I \text{ and } \kappa(y) = Ky \text{ for every } Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle \in (IVIFM)_n$$

$$(P_2) N([Q_\mu, Q_\lambda]_L) = N([Q_\mu, Q_\lambda]_L K) = N(K[Q_\mu, Q_\lambda]_L)$$

$$N([Q_\mu, Q_\lambda]_U) = N([Q_\mu, Q_\lambda]_U K) = N(K[Q_\mu, Q_\lambda]_U)$$

$$(P_3) ([Q_\mu, Q_\lambda]_L K)^+ = K[Q_\mu, Q_\lambda]_L^+ \text{ and } ([Q_\mu, Q_\lambda]_L)^+ = [Q_\mu, Q_\lambda]_L^+ K \text{ exists, if } [Q_\mu, Q_\lambda]_L^+ \text{ exists.}$$

$$([Q_\mu, Q_\lambda]_U K)^+ = K[Q_\mu, Q_\lambda]_U^+ \text{ and } (K[Q_\mu, Q_\lambda]_U)^+ = [Q_\mu, Q_\lambda]_U^+ K \text{ exists, if } [Q_\mu, Q_\lambda]_U^+ \text{ exists.}$$

$$(P_4) [Q_\mu, Q_\lambda]_L^+ \text{ is a g-inverse of } [Q_\mu, Q_\lambda]_L \text{ iff } [Q_\mu, Q_\lambda]_L^+ \text{ exist}$$

$$[Q_\mu, Q_\lambda]_U^+ \text{ is a g-inverse of } [Q_\mu, Q_\lambda]_U \text{ iff } [Q_\mu, Q_\lambda]_U^+ \text{ exist}$$

2.1 Notations: For NFM of $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle \in (IVIFM)_n$

$$[Q_\mu, Q_\lambda]_L^T : \text{Transpose of } [Q_\mu, Q_\lambda]_L,$$

$$[Q_\mu, Q_\lambda]_U^T : \text{Transpose of } [Q_\mu, Q_\lambda]_U,$$

$$R([Q_\mu, Q_\lambda]_L) : \text{Row space of } [Q_\mu, Q_\lambda]_L,$$

$$R([Q_\mu, Q_\lambda]_U) : \text{Row space of } [Q_\mu, Q_\lambda]_U,$$

$$C([Q_\mu, Q_\lambda]_L) : \text{Column space of } [Q_\mu, Q_\lambda]_L$$

$$C([Q_\mu, Q_\lambda]_U) : \text{Column space of } [Q_\mu, Q_\lambda]_U$$





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$N([Q_\mu, Q_\lambda]_L)$: Null Space of $[Q_\mu, Q_\lambda]_L$,

$N([Q_\mu, Q_\lambda]_U)$: Null Space of $[Q_\mu, Q_\lambda]_U$,

$[Q_\mu, Q_\lambda]_L^+$: Moore-Penrose inverse of $[Q_\mu, Q_\lambda]_L$,

$[Q_\mu, Q_\lambda]_U^+$: Moore-Penrose inverse of $[Q_\mu, Q_\lambda]_U$,

IVIFM : Interval valued Intuitionistic fuzzy matrices.

PIFM : Permutation Intuitionistic fuzzy matrices.

DEFINITIONS AND THEOREMS

Definition:2.1 (IVNFM): An IVIFM A of order $m \times n$ is denoted as $A = [x_{ij}, \langle a_{ij\mu}, a_{ij\lambda} \rangle]_{m \times n}$ where $a_{ij\mu}$ and $a_{ij\lambda}$ are the subsets of $[0,1]$ which are denoted by $a_{ij\mu} = [a_{ij\mu L}, a_{ij\mu U}]$ and $a_{ij\lambda} = [a_{ij\lambda L}, a_{ij\lambda U}]$ which maintaining the condition $0 \leq a_{ij\mu U} + a_{ij\lambda U} \leq 1$, $0 \leq a_{ij\mu L} + a_{ij\lambda L} \leq 1$, $0 \leq a_{\mu L} \leq a_{\mu U} \leq 1$, $0 \leq a_{\lambda L} \leq a_{\lambda U} \leq 1$.

Example2.1 Consider an IVIFM

$$Q = \begin{bmatrix} \langle [0,0], [1,1] \rangle & \langle [0.1,0.3], [0.2,0.4] \rangle \\ \langle [0.1,0.3], [0.2,0.4] \rangle & \langle [0,0], [1,1] \rangle \end{bmatrix}$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0,1 \rangle & \langle 0.1,0.2 \rangle \\ \langle 0.1,0.2 \rangle & \langle 0,1 \rangle \end{bmatrix},$$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0,1 \rangle & \langle 0.3,0.4 \rangle \\ \langle 0.3,0.4 \rangle & \langle 0,1 \rangle \end{bmatrix}$$

Definition: 2.2 Let $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle$ be a IVIFM, if $R[[Q_\mu, Q_\lambda]_L] =$

$R[[Q_\mu, Q_\lambda]_L^T]$ and $R[[Q_\mu, Q_\lambda]_U] = R[[Q_\mu, Q_\lambda]_U^T]$ then Q is called as RS.

Example: 2.2 Consider an IVIFM

$$Q = \begin{bmatrix} \langle [0.4,0.5], [0,0] \rangle & \langle [1,1], [0,0] \rangle & \langle [0.2,0.5], [0.3,0.6] \rangle \\ \langle [1,1], [0,0] \rangle & \langle [1,1], [0,0] \rangle & \langle [1,1], [0,0] \rangle \\ \langle [0.2,0.5], [0.3,0.6] \rangle & \langle [1,1], [0,0] \rangle & \langle [1,1], [0,0] \rangle \end{bmatrix},$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.4,0 \rangle & \langle 1,0 \rangle & \langle 0.2,0.3 \rangle \\ \langle 1,0 \rangle & \langle 1,0 \rangle & \langle 1,0 \rangle \\ \langle 0.2,0.3 \rangle & \langle 1,0 \rangle & \langle 1,0 \rangle \end{bmatrix}$$

Here, $R[[Q_\mu, Q_\lambda]_L] = R[[Q_\mu, Q_\lambda]_L^T]$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.5,0 \rangle & \langle 1,0 \rangle & \langle 0.5,0.6 \rangle \\ \langle 1,0 \rangle & \langle 1,0 \rangle & \langle 1,0 \rangle \\ \langle 0.5,0.6 \rangle & \langle 1,0 \rangle & \langle 1,0 \rangle \end{bmatrix}$$

Here, $R[[Q_\mu, Q_\lambda]_U] = R[[Q_\mu, Q_\lambda]_U^T]$





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The following matrices does not satisfies the range symmetric condition

$$Q = \begin{bmatrix} \langle [0.4, 0.5], [0, 0] \rangle & \langle [1, 1], [0, 0] \rangle & \langle [0.2, 0.5], [0.3, 0.6] \rangle \\ \langle [1, 1], [0, 0] \rangle & \langle [1, 1], [0, 0] \rangle & \langle [1, 1], [0, 0] \rangle \\ \langle [0.2, 0.7], [0.4, 0.6] \rangle & \langle [1, 1], [0, 0] \rangle & \langle [1, 1], [0, 0] \rangle \end{bmatrix}$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.4, 0 \rangle & \langle 1, 0 \rangle & \langle 0.2, 0.3 \rangle \\ \langle 1, 0 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \\ \langle 0.2, 0.4 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \end{bmatrix},$$

$$[Q_\mu, Q_\lambda]_L^T = \begin{bmatrix} \langle 0.4, 0 \rangle & \langle 1, 0 \rangle & \langle 0.2, 0.4 \rangle \\ \langle 1, 0 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \\ \langle 0.2, 0.3 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \end{bmatrix}$$

$$[(0.4, 0) (1, 0) (0.2, 0.3)] \in R([Q_\mu, Q_\lambda]_L), [(0.4, 0) (1, 0) (0.2, 0.3)] \notin R([Q_\mu, Q_\lambda]_L^T)$$

$$[(1, 0) (1, 0) (1, 0)] \in R([Q_\mu, Q_\lambda]_L), [(1, 0) (1, 0) (1, 0)] \in R([Q_\mu, Q_\lambda]_L^T)$$

$$[(0.2, 0.4) (1, 0) (1, 0)] \in R([Q_\mu, Q_\lambda]_L), [(0.2, 0.4) (1, 0) (1, 0)] \notin R([Q_\mu, Q_\lambda]_L^T)$$

$$R([Q_\mu, Q_\lambda]_L) \neq R([Q_\mu, Q_\lambda]_L^T)$$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.5, 0 \rangle & \langle 1, 0 \rangle & \langle 0.5, 0.6 \rangle \\ \langle 1, 0 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \\ \langle 0.7, 0.6 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \end{bmatrix}$$

$$\text{Similarly, } R([Q_\mu, Q_\lambda]_U) \neq R([Q_\mu, Q_\lambda]_U^T)$$

Note:2.1 For NFM $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle \in (IVIFM)_n$ with $\det [Q_\mu, Q_\lambda]_L > \langle 0, 0 \rangle$ and $\det [Q_\mu, Q_\lambda]_U > \langle 0, 0 \rangle$ has non-zero rows and non-columns, hereafter $N([Q_\mu, Q_\lambda]_L) = \langle 0, 0 \rangle = N([Q_\mu, Q_\lambda]_L^T)$ and $N([Q_\mu, Q_\lambda]_U) = \langle 0, 0 \rangle = N([Q_\mu, Q_\lambda]_U^T)$. Furthermore, a symmetric matrix $[Q_\mu, Q_\lambda]_L = [Q_\mu, Q_\lambda]_L^T$, $[Q_\mu, Q_\lambda]_U = [Q_\mu, Q_\lambda]_U^T$ that is $N([Q_\mu, Q_\lambda]_L) = N([Q_\mu, Q_\lambda]_L^T)$ and $N([Q_\mu, Q_\lambda]_U) = N([Q_\mu, Q_\lambda]_U^T)$.

Definition : 2.3 Let $P \in (IVIFM)_n$, if $N([Q_\mu, Q_\lambda]_L) = N([Q_\mu, Q_\lambda]_L^T)$ and $N([Q_\mu, Q_\lambda]_U) = N([Q_\mu, Q_\lambda]_U^T)$ then $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle$ is called KS-IVIFM where $N([Q_\mu, Q_\lambda]_L) = \{x/x[Q_\mu, Q_\lambda]_L = (0, 0) \text{ and } x \in F_{1 \times n}\}$, and $N([Q_\mu, Q_\lambda]_U) = \{x/x[Q_\mu, Q_\lambda]_U = (0, 0) \text{ and } x \in F_{1 \times n}\}$.

Example: 2.3 Consider an IVIFM

$$Q = \begin{bmatrix} \langle [0.3, 0.4], [0.3, 0.4] \rangle & \langle [0.5, 0.6], [0.3, 0.7] \rangle & \langle [0.2, 0.5], [0.3, 0.6] \rangle \\ \langle [0.4, 0.6], [0.7, 0.8] \rangle & \langle [0.4, 0.7], [0.8, 0.9] \rangle & \langle [0.2, 0.3], [0.5, 0.7] \rangle \\ \langle [0.2, 0.7], [0.4, 0.6] \rangle & \langle [0.4, 0.5], [0.4, 0.6] \rangle & \langle [0.4, 0.5], [0.5, 0.7] \rangle \end{bmatrix}$$





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$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.3, 0.3 \rangle & \langle 0.5, 0.3 \rangle & \langle 0.2, 0.3 \rangle \\ \langle 0.4, 0.7 \rangle & \langle 0.4, 0.8 \rangle & \langle 0.2, 0.5 \rangle \\ \langle 0.2, 0.4 \rangle & \langle 0.4, 0.4 \rangle & \langle 0.4, 0.5 \rangle \end{bmatrix}$$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.4, 0.4 \rangle & \langle 0.6, 0.7 \rangle & \langle 0.5, 0.6 \rangle \\ \langle 0.6, 0.8 \rangle & \langle 0.7, 0.9 \rangle & \langle 0.3, 0.7 \rangle \\ \langle 0.7, 0.6 \rangle & \langle 0.5, 0.6 \rangle & \langle 0.5, 0.5 \rangle \end{bmatrix}$$

$$N([Q_\mu, Q_\lambda]_L) = N([Q_\mu, Q_\lambda]_L^T) = (0, 0)$$

$$N([Q_\mu, Q_\lambda]_U) = N([Q_\mu, Q_\lambda]_U^T) = (0, 0)$$

Definition 2.4. Symmetric IVIFM. If $P \in (IVIFM)_n$ is said to be symmetric IFM if $p_{ij} = p_{ji}$

Example: 2.4 Consider an IVIFM

$$Q = \begin{bmatrix} \langle 0.4, 0.5 \rangle, [0, 0] & \langle 1, 1 \rangle, [0, 0] & \langle 0.2, 0.5 \rangle, [0.3, 0.6] \\ \langle 1, 1 \rangle, [0, 0] & \langle 1, 1 \rangle, [0, 0] & \langle 1, 1 \rangle, [0, 0] \\ \langle 0.2, 0.5 \rangle, [0.3, 0.6] & \langle 1, 1 \rangle, [0, 0] & \langle 1, 1 \rangle, [0, 0] \end{bmatrix},$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.4, 0 \rangle & \langle 1, 0 \rangle & \langle 0.2, 0.3 \rangle \\ \langle 1, 0 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \\ \langle 0.2, 0.3 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \end{bmatrix}$$

$$\text{Here, } [Q_\mu, Q_\lambda]_L = [Q_\mu, Q_\lambda]_L^T$$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.5, 0 \rangle & \langle 1, 0 \rangle & \langle 0.5, 0.6 \rangle \\ \langle 1, 0 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \\ \langle 0.5, 0.6 \rangle & \langle 1, 0 \rangle & \langle 1, 0 \rangle \end{bmatrix}$$

$$\text{Here, } [Q_\mu, Q_\lambda]_U = [Q_\mu, Q_\lambda]_U^T$$

Definition 2.5. Permutation IFM

If each row and each column contains accurately one $\langle 1, 0 \rangle$ and all other entries are $\langle 0, 1 \rangle$ in a square IFM, it is known as intuitionistic Fuzzy permutation matrix.

Example: 2.5 Consider a NFPM, $K = \begin{bmatrix} (1, 0) & (0, 1) & (0, 1) \\ (0, 1) & (1, 0) & (0, 1) \\ (0, 1) & (0, 1) & (1, 0) \end{bmatrix}$





THEOREMS AND RESULTS

Theorem: 4.1 For an IVIFM $P = \langle [P_\mu, P_\lambda]_L, [P_\mu, P_\lambda]_U \rangle$, $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle \in \text{IVIFM}_{mm}$ and K be a IFPM if $N([P_\mu, P_\lambda]_L) = N([Q_\mu, Q_\lambda]_L) \Leftrightarrow N(K[P_\mu, P_\lambda]_L K^T) = N(K[Q_\mu, Q_\lambda]_L K^T)$ and $N([P_\mu, P_\lambda]_U) = N([Q_\mu, Q_\lambda]_U) \Leftrightarrow N(K[P_\mu, P_\lambda]_U K^T) = N(K[Q_\mu, Q_\lambda]_U K^T)$.

Proof: Let $w \in N(K[P_\mu, P_\lambda]_L K^T)$

$$\Rightarrow w(K[P_\mu, P_\lambda]_L K^T) = (0, 0)$$

$$\Rightarrow yK^T = (0, 0) \text{ where } y = wK([P_\mu, P_\lambda]_L)$$

$$\Rightarrow y \in N(K^T)$$

$$\det K = \det K^T > (0, 0)$$

(By Note: 2.1)

$$\text{Therefore, } N(K^T) = (0, 0)$$

$$\text{Hence, } y = (0, 0)$$

$$\Rightarrow wK([P_\mu, P_\lambda]_L) = (0, 0)$$

$$\Rightarrow wK \in N([P_\mu, P_\lambda]_L) = N([Q_\mu, Q_\lambda]_L)$$

$$\Rightarrow wK([Q_\mu, Q_\lambda]_L)K^T = (0, 0)$$

$$\Rightarrow w \in N(K([Q_\mu, Q_\lambda]_L)K^T)$$

$$N(K[P_\mu, P_\lambda]_L K^T) \subseteq N(K[Q_\mu, Q_\lambda]_L K^T)$$

$$\text{Similarly, } N(K[Q_\mu, Q_\lambda]_L K^T) \subseteq N(K[P_\mu, P_\lambda]_L K^T)$$

$$\text{Therefore, } N([P_\mu, P_\lambda]_L) = N([Q_\mu, Q_\lambda]_L) \Leftrightarrow N(K[P_\mu, P_\lambda]_L K^T) = N(K[Q_\mu, Q_\lambda]_L K^T)$$

$$\text{Therefore, } N([P_\mu, P_\lambda]_U) = N([Q_\mu, Q_\lambda]_U) \Leftrightarrow N(K[P_\mu, P_\lambda]_U K^T) = N(K[Q_\mu, Q_\lambda]_U K^T)$$

$$\text{Conversely, if } N(K[P_\mu, P_\lambda]_L K^T) = N(K[Q_\mu, Q_\lambda]_L K^T),$$

$$N([P_\mu, P_\lambda]_L) = N(K^T(K([P_\mu, P_\lambda]_L)K^T)K)$$

$$= N(K^T(K([Q_\mu, Q_\lambda]_L)K^T)K)$$

$$N([P_\mu, P_\lambda]_L) = N([Q_\mu, Q_\lambda]_L)$$

$$\text{Similarly, } N(K[P_\mu, P_\lambda]_U K^T) = N(K[Q_\mu, Q_\lambda]_U K^T) \Leftrightarrow N([P_\mu, P_\lambda]_U) = N([Q_\mu, Q_\lambda]_U)$$

Example: 4.1 Consider an IVIFM

$$P = \begin{bmatrix} \langle [0.3, 0.4], [0.3, 0.4] \rangle & \langle [0.5, 0.6], [0.3, 0.7] \rangle & \langle [0.2, 0.5], [0.3, 0.6] \rangle \\ \langle [0.4, 0.6], [0.7, 0.8] \rangle & \langle [0.4, 0.7], [0.8, 0.9] \rangle & \langle [0.2, 0.3], [0.5, 0.7] \rangle \\ \langle [0.2, 0.7], [0.4, 0.6] \rangle & \langle [0.4, 0.5], [0.4, 0.6] \rangle & \langle [0.4, 0.5], [0.5, 0.7] \rangle \end{bmatrix}$$





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$$\text{Lower Limit IFM, } [P_\mu, P_\lambda]_L = \begin{bmatrix} \langle 0.3, 0.3 \rangle & \langle 0.5, 0.3 \rangle & \langle 0.2, 0.3 \rangle \\ \langle 0.4, 0.7 \rangle & \langle 0.4, 0.8 \rangle & \langle 0.2, 0.5 \rangle \\ \langle 0.2, 0.4 \rangle & \langle 0.4, 0.4 \rangle & \langle 0.4, 0.5 \rangle \end{bmatrix}$$

$$\text{Upper Limit IFM, } [P_\mu, P_\lambda]_U = \begin{bmatrix} \langle 0.4, 0.4 \rangle & \langle 0.6, 0.7 \rangle & \langle 0.5, 0.6 \rangle \\ \langle 0.6, 0.8 \rangle & \langle 0.7, 0.9 \rangle & \langle 0.3, 0.7 \rangle \\ \langle 0.7, 0.6 \rangle & \langle 0.5, 0.6 \rangle & \langle 0.5, 0.5 \rangle \end{bmatrix}$$

$$K = \begin{bmatrix} (1,0) & (0,1) & (0,1) \\ (0,1) & (1,0) & (0,1) \\ (0,1) & (0,1) & (1,0) \end{bmatrix}$$

$$Q = \begin{bmatrix} \langle [0.5, 0.6], [0.3, 0.4] \rangle & \langle [0.4, 0.5], [0.3, 0.4] \rangle & \langle [0.3, 0.5], [0.4, 0.6] \rangle \\ \langle [0.5, 0.6], [0.7, 0.8] \rangle & \langle [0.4, 0.5], [0.8, 0.9] \rangle & \langle [0.2, 0.3], [0.5, 0.7] \rangle \\ \langle [0.2, 0.3], [0.4, 0.5] \rangle & \langle [0.4, 0.6], [0.4, 0.7] \rangle & \langle [0.4, 0.6], [0.5, 0.5] \rangle \end{bmatrix}$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.5, 0.3 \rangle & \langle 0.4, 0.3 \rangle & \langle 0.3, 0.4 \rangle \\ \langle 0.5, 0.7 \rangle & \langle 0.4, 0.8 \rangle & \langle 0.2, 0.5 \rangle \\ \langle 0.2, 0.4 \rangle & \langle 0.4, 0.4 \rangle & \langle 0.4, 0.5 \rangle \end{bmatrix}$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.6, 0.4 \rangle & \langle 0.5, 0.4 \rangle & \langle 0.5, 0.6 \rangle \\ \langle 0.6, 0.8 \rangle & \langle 0.5, 0.9 \rangle & \langle 0.3, 0.7 \rangle \\ \langle 0.3, 0.5 \rangle & \langle 0.6, 0.7 \rangle & \langle 0.6, 0.5 \rangle \end{bmatrix}$$

Theorem:4.2 For an IVIFM $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle \in (IVIFM)_n$ and K be a IFPM if

$$N([Q_\mu, Q_\lambda]_L) = N([Q_\mu, Q_\lambda]_L^T) \Leftrightarrow N(K[Q_\mu, Q_\lambda]_L K^T) = N(K[Q_\mu, Q_\lambda]_L^T K^T) \quad \text{and}$$

$$N([Q_\mu, Q_\lambda]_U) = N([Q_\mu, Q_\lambda]_U^T) \Leftrightarrow N(K[Q_\mu, Q_\lambda]_U K^T) = N(K[Q_\mu, Q_\lambda]_U^T K^T).$$

Proof: Let $x \in N(K[Q_\mu, Q_\lambda]_L K^T)$

$$\Rightarrow x(K[Q_\mu, Q_\lambda]_L K^T) = (0, 0)$$

$$\Rightarrow w K^T = (0, 0) \text{ where } w = x K[Q_\mu, Q_\lambda]_L$$

$$\Rightarrow w \in N(K^T)$$

$$\det K = \det K^T > (0, 0)$$

$$N(K^T) = (0, 0)$$

$$\text{Here, } w = (0, 0)$$

$$\Rightarrow x K[Q_\mu, Q_\lambda]_L = (0, 0)$$

$$\Rightarrow x K \in N([Q_\mu, Q_\lambda]_L) = N([Q_\mu, Q_\lambda]_L^T)$$





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$$\Rightarrow xK[Q_\mu, Q_\lambda]_L^T K^T = (0, 0)$$

$$\Rightarrow x \in N(K[Q_\mu, Q_\lambda]_L K^T)$$

$$N(K[Q_\mu, Q_\lambda]_L K^T) \subseteq N(K[Q_\mu, Q_\lambda]_L^T K^T)$$

$$\text{Similarly, } N(K[Q_\mu, Q_\lambda]_L^T K^T) \subseteq N(K[Q_\mu, Q_\lambda]_L K^T)$$

$$\text{Therefore, } N(K[Q_\mu, Q_\lambda]_L K^T) = N(K[Q_\mu, Q_\lambda]_L^T K^T)$$

$$\text{Conversely, if } N(K[Q_\mu, Q_\lambda]_L K^T) = N(K[Q_\mu, Q_\lambda]_L^T K^T),$$

$$N([Q_\mu, Q_\lambda]_L) = N(K^T(K[Q_\mu, Q_\lambda]_L K^T)K)$$

$$= N(K^T(K[Q_\mu, Q_\lambda]_L^T K^T)K)$$

$$N([Q_\mu, Q_\lambda]_L) = N([Q_\mu, Q_\lambda]_L^T).$$

$$N([Q_\mu, Q_\lambda]_L) = N([Q_\mu, Q_\lambda]_L^T) \Leftrightarrow N(K[Q_\mu, Q_\lambda]_L K^T) = N(K[Q_\mu, Q_\lambda]_L^T K^T)$$

$$\text{Similarly, } N([Q_\mu, Q_\lambda]_U) = N([Q_\mu, Q_\lambda]_U^T) \Leftrightarrow N(K[Q_\mu, Q_\lambda]_U K^T) = N(K[Q_\mu, Q_\lambda]_U^T K^T). \text{ Example: 4.2}$$

Consider an IVIFM

$$Q = \begin{bmatrix} \langle 0.7, 0.8 \rangle, [0.3, 0.4] & \langle 0.5, 0.7 \rangle, [0.3, 0.7] & \langle 0.2, 0.3 \rangle, [0.3, 0.6] \\ \langle 0.4, 0.6 \rangle, [0.7, 0.9] & \langle 0.4, 0.5 \rangle, [0.8, 0.9] & \langle 0.2, 0.3 \rangle, [0.5, 0.8] \\ \langle 0.2, 0.2 \rangle, [0.4, 0.6] & \langle 0.4, 0.5 \rangle, [0.4, 0.7] & \langle 0.4, 0.5 \rangle, [0.5, 0.5] \end{bmatrix}$$

$$K = \begin{bmatrix} (1, 0) & (0, 1) & (0, 1) \\ (0, 1) & (1, 0) & (0, 1) \\ (0, 1) & (0, 1) & (1, 0) \end{bmatrix}$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.7, 0.3 \rangle & \langle 0.5, 0.3 \rangle & \langle 0.2, 0.3 \rangle \\ \langle 0.4, 0.7 \rangle & \langle 0.4, 0.8 \rangle & \langle 0.2, 0.5 \rangle \\ \langle 0.2, 0.4 \rangle & \langle 0.4, 0.4 \rangle & \langle 0.4, 0.5 \rangle \end{bmatrix}$$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.8, 0.4 \rangle & \langle 0.7, 0.7 \rangle & \langle 0.3, 0.6 \rangle \\ \langle 0.6, 0.9 \rangle & \langle 0.5, 0.9 \rangle & \langle 0.3, 0.8 \rangle \\ \langle 0.2, 0.6 \rangle & \langle 0.5, 0.7 \rangle & \langle 0.5, 0.5 \rangle \end{bmatrix}$$

Theorem: 4.3 For $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle \in (IVIFM)_n$ is kernel symmetric IVIFM, then $N([Q_\mu, Q_\lambda]_L$

$$[Q_\mu, Q_\lambda]_L^T) = N([Q_\mu, Q_\lambda]_L) = N([Q_\mu, Q_\lambda]_L^T [Q_\mu, Q_\lambda]_L)$$

$$\text{and } N([Q_\mu, Q_\lambda]_U [Q_\mu, Q_\lambda]_U [Q_\mu, Q_\lambda]_U^T) = N([Q_\mu, Q_\lambda]_U) = N([Q_\mu, Q_\lambda]_U^T [Q_\mu, Q_\lambda]_U).$$

Example: 4.3 Consider an IVIFM





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$$Q = \begin{bmatrix} \langle [0.1, 0.2], [0.3, 0.4] \rangle & \langle [0.4, 0.6], [0.3, 0.8] \rangle & \langle [0.2, 0.9], [0.3, 0.9] \rangle \\ \langle [0.4, 0.5], [0.7, 1] \rangle & \langle [0.4, 0.7], [0.7, 0.8] \rangle & \langle [0.2, 0.2], [0.5, 0.7] \rangle \\ \langle [0.2, 0.2], [0.3, 0.6] \rangle & \langle [0.4, 0.5], [0.3, 0.7] \rangle & \langle [0.4, 0.5], [0.2, 0.5] \rangle \end{bmatrix}$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.1, 0.3 \rangle & \langle 0.4, 0.3 \rangle & \langle 0.2, 0.3 \rangle \\ \langle 0.4, 0.7 \rangle & \langle 0.4, 0.7 \rangle & \langle 0.2, 0.5 \rangle \\ \langle 0.2, 0.3 \rangle & \langle 0.4, 0.3 \rangle & \langle 0.4, 0.2 \rangle \end{bmatrix}$$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.2, 0.4 \rangle & \langle 0.6, 0.8 \rangle & \langle 0.9, 0.9 \rangle \\ \langle 0.5, 1 \rangle & \langle 0.7, 0.8 \rangle & \langle 0.2, 0.7 \rangle \\ \langle 0.2, 0.6 \rangle & \langle 0.5, 0.7 \rangle & \langle 0.5, 0.5 \rangle \end{bmatrix}$$

Theorem:4.5 For a IVIFM $P = \langle [P_\mu, P_\lambda]_L, [P_\mu, P_\lambda]_U \rangle$, $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle \in \text{IVIFM}_{mn}$ and K IFPM, $R([P_\mu, P_\lambda]_L) = R([Q_\mu, Q_\lambda]_L) \Leftrightarrow R(K[P_\mu, P_\lambda]_L K^T) = R(K[Q_\mu, Q_\lambda]_L K^T)$ and $R([P_\mu, P_\lambda]_U) = R([Q_\mu, Q_\lambda]_U) \Leftrightarrow R(K[P_\mu, P_\lambda]_U K^T) = R(K[Q_\mu, Q_\lambda]_U K^T)$.

Proof: Let $R([P_\mu, P_\lambda]_L) = R([Q_\mu, Q_\lambda]_L)$

Then, $R([P_\mu, P_\lambda]_L K^T) = R([P_\mu, P_\lambda]_L) K^T$

$= R([P_\mu, P_\lambda]_L) K^T$

$= R([P_\mu, P_\lambda]_L K^T)$

Let $z \in \{R(K[P_\mu, P_\lambda]_L K^T)\}$

$z = w(K[P_\mu, P_\lambda]_L K^T)$ for some $w \in V^n$

$z = r[P_\mu, P_\lambda]_L K^T$, $r = wK$

$z \in R([P_\mu, P_\lambda]_L K^T) = R([Q_\mu, Q_\lambda]_L K^T)$

$z = u[Q_\mu, Q_\lambda]_L K^T$ for some $u \in V^n$

$z = (uK^T) K[Q_\mu, Q_\lambda]_L K^T$

$z = vK[Q_\mu, Q_\lambda]_L K^T$ for some $v \in V^n$

$z \in R(K[Q_\mu, Q_\lambda]_L K^T)$

Therefore, $R(K[P_\mu, P_\lambda]_L K^T) \subseteq R(K[Q_\mu, Q_\lambda]_L K^T)$

Similarly, $R(K[Q_\mu, Q_\lambda]_L K^T) \subseteq R(K[P_\mu, P_\lambda]_L K^T)$

Therefore, $R(K[P_\mu, P_\lambda]_L K^T) = R(K[Q_\mu, Q_\lambda]_L K^T)$

Conversely, Let $R(K[P_\mu, P_\lambda]_L K^T) = R(K[Q_\mu, Q_\lambda]_L K^T)$





$$\begin{aligned}
 R([P_\mu, P_\lambda]_L) &= R[K^T (K[P_\mu, P_\lambda]_L K^T) K] \\
 &= R[K^T (K[Q_\mu, Q_\lambda]_L K^T) K] \\
 &= R([Q_\mu, Q_\lambda]_L) \\
 R([P_\mu, P_\lambda]_L) &= R([Q_\mu, Q_\lambda]_L)
 \end{aligned}$$

Similarly, $R([P_\mu, P_\lambda]_U) = R([Q_\mu, Q_\lambda]_U) \Leftrightarrow R(K[P_\mu, P_\lambda]_U K^T) = R(K[Q_\mu, Q_\lambda]_U K^T)$.

Example: 4.5 Consider an IVNFM

$$P = \begin{bmatrix} \langle 0.1, 0.2 \rangle, [0.3, 0.4] > & \langle 0.4, 0.6 \rangle, [0.3, 0.8] > & \langle 0.2, 0.9 \rangle, [0.3, 0.9] > \\ \langle 0.4, 0.6 \rangle, [0.3, 0.8] > & \langle 0.4, 0.7 \rangle, [0.7, 0.8] > & \langle 0.2, 0.2 \rangle, [0.5, 0.7] > \\ \langle 0.2, 0.9 \rangle, [0.3, 0.9] > & \langle 0.2, 0.2 \rangle, [0.5, 0.7] > & \langle 0.4, 0.5 \rangle, [0.2, 0.5] > \end{bmatrix}$$

$$K = \begin{bmatrix} (1, 0) & (0, 1) & (0, 1) \\ (0, 1) & (1, 0) & (0, 1) \\ (0, 1) & (0, 1) & (1, 0) \end{bmatrix}$$

$$\text{Lower Limit IFM, } [P_\mu, P_\lambda]_L = \begin{bmatrix} \langle 0.1, 0.3 \rangle & \langle 0.4, 0.3 \rangle & \langle 0.2, 0.3 \rangle \\ \langle 0.4, 0.3 \rangle & \langle 0.4, 0.7 \rangle & \langle 0.2, 0.5 \rangle \\ \langle 0.2, 0.3 \rangle & \langle 0.2, 0.5 \rangle & \langle 0.4, 0.2 \rangle \end{bmatrix}$$

$$\text{Upper Limit IFM, } [P_\mu, P_\lambda]_U = \begin{bmatrix} \langle 0.2, 0.4 \rangle & \langle 0.6, 0.8 \rangle & \langle 0.9, 0.9 \rangle \\ \langle 0.6, 0.8 \rangle & \langle 0.9, 0.9 \rangle & \langle 0.2, 0.7 \rangle \\ \langle 0.9, 0.9 \rangle & \langle 0.2, 0.7 \rangle & \langle 0.5, 0.5 \rangle \end{bmatrix}$$

$$Q = \begin{bmatrix} \langle 0.2, 0.9 \rangle, [0.3, 0.9] > & \langle 0.2, 0.2 \rangle, [0.5, 0.7] > & \langle 0.4, 0.5 \rangle, [0.2, 0.5] > \\ \langle 0.4, 0.6 \rangle, [0.3, 0.8] > & \langle 0.4, 0.7 \rangle, [0.7, 0.8] > & \langle 0.2, 0.2 \rangle, [0.5, 0.7] > \\ \langle 0.1, 0.2 \rangle, [0.3, 0.4] > & \langle 0.4, 0.6 \rangle, [0.3, 0.8] > & \langle 0.2, 0.9 \rangle, [0.3, 0.9] > \end{bmatrix}$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.2, 0.3 \rangle & \langle 0.2, 0.5 \rangle & \langle 0.4, 0.2 \rangle \\ \langle 0.4, 0.3 \rangle & \langle 0.4, 0.7 \rangle & \langle 0.2, 0.5 \rangle \\ \langle 0.1, 0.3 \rangle & \langle 0.4, 0.3 \rangle & \langle 0.2, 0.3 \rangle \end{bmatrix}$$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.9, 0.9 \rangle & \langle 0.2, 0.7 \rangle & \langle 0.5, 0.5 \rangle \\ \langle 0.6, 0.8 \rangle & \langle 0.7, 0.8 \rangle & \langle 0.2, 0.7 \rangle \\ \langle 0.2, 0.4 \rangle & \langle 0.6, 0.8 \rangle & \langle 0.9, 0.9 \rangle \end{bmatrix}$$

$$R([P_\mu, P_\lambda]_L) = R([Q_\mu, Q_\lambda]_L) \Leftrightarrow R(K[P_\mu, P_\lambda]_L K^T) = R(K[Q_\mu, Q_\lambda]_L K^T) \text{ and}$$

$$R([P_\mu, P_\lambda]_U) = R([Q_\mu, Q_\lambda]_U) \Leftrightarrow R(K[P_\mu, P_\lambda]_U K^T) = R(K[Q_\mu, Q_\lambda]_U K^T).$$





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Theorem:4.6 For $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle$ be the IVIFM and K be a IFPM, $R([Q_\mu, Q_\lambda]_L) = R([Q_\mu, Q_\lambda]_L^T) \Leftrightarrow R(K[Q_\mu, Q_\lambda]_L K^T) = R(K[Q_\mu, Q_\lambda]_L^T K^T)$ and $R([Q_\mu, Q_\lambda]_U) = R([Q_\mu, Q_\lambda]_U^T) \Leftrightarrow R(K[Q_\mu, Q_\lambda]_U K^T) = R(K[Q_\mu, Q_\lambda]_U^T K^T)$.

Example: 4.6 Consider an IVIFM

$$Q = \begin{bmatrix} \langle [0.2, 0.2], [0.1, 0.4] \rangle & \langle [0.3, 0.5], [0.3, 0.8] \rangle & \langle [0.4, 0.7], [0.5, 0.6] \rangle \\ \langle [0.3, 0.5], [0.3, 0.8] \rangle & \langle [0.4, 0.7], [0.7, 0.8] \rangle & \langle [0.4, 0.7], [0.5, 0.7] \rangle \\ \langle [0.4, 0.7], [0.5, 0.6] \rangle & \langle [0.4, 0.7], [0.5, 0.7] \rangle & \langle [0.3, 0.4], [1, 0.1] \rangle \end{bmatrix}$$

$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.2, 0.1 \rangle & \langle 0.3, 0.3 \rangle & \langle 0.4, 0.5 \rangle \\ \langle 0.3, 0.3 \rangle & \langle 0.4, 0.7 \rangle & \langle 0.4, 0.5 \rangle \\ \langle 0.4, 0.5 \rangle & \langle 0.4, 0.5 \rangle & \langle 0.3, 1 \rangle \end{bmatrix}$$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.2, 0.4 \rangle & \langle 0.5, 0.8 \rangle & \langle 0.7, 0.6 \rangle \\ \langle 0.5, 0.8 \rangle & \langle 0.7, 0.8 \rangle & \langle 0.7, 0.7 \rangle \\ \langle 0.7, 0.6 \rangle & \langle 0.7, 0.7 \rangle & \langle 0.4, 0.1 \rangle \end{bmatrix}$$

Theorem:4.7 For a IVIFM $P = \langle [P_\mu, P_\lambda]_L, [P_\mu, P_\lambda]_U \rangle$, $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle \in \text{IVIFM}_{nn}$ and K IFPM $C([P_\mu, P_\lambda]_L) = C([Q_\mu, Q_\lambda]_L) \Leftrightarrow C(K[P_\mu, P_\lambda]_L K^T) = C(K[Q_\mu, Q_\lambda]_L K^T)$ and $C([P_\mu, P_\lambda]_U) = C([Q_\mu, Q_\lambda]_U) \Leftrightarrow C(K[P_\mu, P_\lambda]_U K^T) = C(K[Q_\mu, Q_\lambda]_U K^T)$.

Example: 4.7 Consider an IVIFM

$$P = \begin{bmatrix} \langle [0.1, 0.1], [0.1, 0.4] \rangle & \langle [0.3, 0.5], [0.3, 0.8] \rangle & \langle [0.4, 0.4], [0.5, 0.5] \rangle \\ \langle [0.2, 0.5], [0.3, 0.5] \rangle & \langle [0.4, 0.7], [0.7, 0.8] \rangle & \langle [0.4, 0.6], [0.5, 0.5] \rangle \\ \langle [0.4, 0.4], [0.5, 0.6] \rangle & \langle [0.4, 0.7], [0.5, 0.7] \rangle & \langle [0.4, 0.4], [0.1, 0.1] \rangle \end{bmatrix}$$

$$\text{Lower Limit IFM, } [P_\mu, P_\lambda]_L = \begin{bmatrix} \langle 0.1, 0.1 \rangle & \langle 0.3, 0.3 \rangle & \langle 0.4, 0.5 \rangle \\ \langle 0.2, 0.3 \rangle & \langle 0.4, 0.7 \rangle & \langle 0.4, 0.5 \rangle \\ \langle 0.4, 0.5 \rangle & \langle 0.4, 0.5 \rangle & \langle 0.4, 0.1 \rangle \end{bmatrix}$$

$$\text{Upper Limit IFM, } [P_\mu, P_\lambda]_U = \begin{bmatrix} \langle 0.1, 0.4 \rangle & \langle 0.5, 0.8 \rangle & \langle 0.4, 0.5 \rangle \\ \langle 0.5, 0.5 \rangle & \langle 0.7, 0.8 \rangle & \langle 0.6, 0.5 \rangle \\ \langle 0.4, 0.6 \rangle & \langle 0.7, 0.7 \rangle & \langle 0.4, 0.1 \rangle \end{bmatrix}$$

$$Q = \begin{bmatrix} \langle [0.4, 0.4], [0.5, 0.5] \rangle & \langle [0.3, 0.5], [0.3, 0.8] \rangle & \langle [0.1, 0.1], [0.1, 0.4] \rangle \\ \langle [0.4, 0.6], [0.5, 0.5] \rangle & \langle [0.4, 0.7], [0.7, 0.8] \rangle & \langle [0.2, 0.5], [0.3, 0.5] \rangle \\ \langle [0.4, 0.4], [0.1, 0.1] \rangle & \langle [0.4, 0.7], [0.5, 0.7] \rangle & \langle [0.4, 0.4], [0.5, 0.6] \rangle \end{bmatrix}$$





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$$\text{Lower Limit IFM, } [Q_\mu, Q_\lambda]_L = \begin{bmatrix} \langle 0.4, 0.5 \rangle & \langle 0.3, 0.3 \rangle & \langle 0.1, 0.1 \rangle \\ \langle 0.4, 0.5 \rangle & \langle 0.4, 0.7 \rangle & \langle 0.2, 0.3 \rangle \\ \langle 0.4, 0.1 \rangle & \langle 0.4, 0.5 \rangle & \langle 0.4, 0.5 \rangle \end{bmatrix}$$

$$\text{Upper Limit IFM, } [Q_\mu, Q_\lambda]_U = \begin{bmatrix} \langle 0.4, 0.5 \rangle & \langle 0.5, 0.8 \rangle & \langle 0.1, 0.4 \rangle \\ \langle 0.6, 0.5 \rangle & \langle 0.7, 0.8 \rangle & \langle 0.5, 0.5 \rangle \\ \langle 0.4, 0.1 \rangle & \langle 0.7, 0.7 \rangle & \langle 0.4, 0.6 \rangle \end{bmatrix}$$

Therefore,

$$C([P_\mu, P_\lambda]_L) = C([Q_\mu, Q_\lambda]_L) \Leftrightarrow C(K[P_\mu, P_\lambda]_L K^T) = C(K[Q_\mu, Q_\lambda]_L K^T) \text{ and}$$

$$C([P_\mu, P_\lambda]_U) = C([Q_\mu, Q_\lambda]_U) \Leftrightarrow C(K[P_\mu, P_\lambda]_U K^T) = C(K[Q_\mu, Q_\lambda]_U K^T).$$

k-KERNEL SYMMETRIC IVIFM

Definition: 5.1 Let $Q = \langle [Q_\mu, Q_\lambda]_L, [Q_\mu, Q_\lambda]_U \rangle \in \text{IVIFM}_{nm}$ is called k-KS IVIFM if $N([Q_\mu, Q_\lambda]_L) = N(K[Q_\mu, Q_\lambda]_L K^T)$ and $N([Q_\mu, Q_\lambda]_U) = N(K[Q_\mu, Q_\lambda]_U K^T)$.

Note:5.1 Let $P = \langle [P_\mu, P_\lambda]_L, [P_\mu, P_\lambda]_U \rangle \in \text{IVIFM}_{nm}$ is k-Symmetric IVIFM implies it is

k-KS- IVIFM, for $[Q_\mu, Q_\lambda]_L = K([Q_\mu, Q_\lambda]_L K^T)K$, $[P_\mu, P_\lambda]_U = K([P_\mu, P_\lambda]_U K^T)K$ spontaneously

Example 5.1 shows that if and only if need not be true.

Example: 5.1 Consider an IVIFM

$$Q = \begin{bmatrix} \langle [0, 0.1], [0, 0.4] \rangle & \langle [0, 0.5], [0, 0.8] \rangle & \langle [0.3, 0.4], [0.4, 0.5] \rangle \\ \langle [0.5, 0.5], [0.4, 0.5] \rangle & \langle [0.1, 0.7], [0.4, 0.8] \rangle & \langle [0, 0.6], [0, 0.5] \rangle \\ \langle [0.4, 0.4], [0.5, 0.6] \rangle & \langle [0.3, 0.7], [0.4, 0.7] \rangle & \langle [0, 0.4], [0, 0.1] \rangle \end{bmatrix}$$

$$K = \begin{bmatrix} (0,1) & (0,1) & (1,0) \\ (0,1) & (1,0) & (0,1) \\ (1,0) & (0,1) & (0,1) \end{bmatrix}$$

$$[Q_\mu, Q_\lambda]_L = \begin{bmatrix} (0,0) & (0,0) & (0.3,0.4) \\ (0.5,0.4) & (0.1,0.4) & (0,0) \\ (0.4,0.5) & (0.3,0.4) & (0,0) \end{bmatrix}$$

$$K[Q_\mu, Q_\lambda]_L^T K = \begin{bmatrix} (0,0) & (0,0) & (0.3,0.4) \\ (0.3,0) & (0.1,0) & (0,0.4) \\ (0.4,0) & (0.5,0) & (0,0.4) \end{bmatrix}$$

Therefore, $[Q_\mu, Q_\lambda]_L \neq K[Q_\mu, Q_\lambda]_L^T K$

But, $N([Q_\mu, Q_\lambda]_L) = N(K[Q_\mu, Q_\lambda]_L^T K) = (0,0)$





Similarly,

Therefore, $[Q_\mu, Q_\lambda]_U \neq K[Q_\mu, Q_\lambda]_U^T K$

But, $N([Q_\mu, Q_\lambda]_U) = N(K[Q_\mu, Q_\lambda]_U^T K) = (0, 0)$

CONCLUSION

The theorems explain the properties of RS and KS IVIFMs. With the help of relevant examples, we introduced the concept of KS and k-KS IVIFMs. We also explored different results relating to – KS-IVIFMs and provided examples that helped explain these findings. In the future, we will prove additional properties relating to g-inverses of k-Kernel Symmetric IVNFM.

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Harnessing Hybrid Deep Learning for the Optimal Matching of Fertilizers to Soil Texture to Enhance Agricultural Yield

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ABSTRACT

The chief occupation of agriculture utilizes a major portion of the land for crop plantation and apply fertilizers of diverse nature to enhance the soil fertility. The soil's texture plays a crucial role in its ability to retain and absorb nutrients from applied fertilizers. Unfortunately, many farmers lack the knowledge needed to select the right fertilizers that match their soil's texture. This lack of awareness places a substantial financial burden on farmers and results in significantly reduced crop yields. Moreover, the misalignment between fertilizers and soil texture negatively impacts soil quality, leading to economic losses for farmers and jeopardizing their livelihoods. Hence, it is imperative to develop a predictive model that empowers farmers to make informed decisions regarding the selection of appropriate fertilizers tailored to their specific soil textures. This research work utilizes the capabilities of hybrid deep learning to tackle these challenges, offering precise and customized fertilizer recommendations based on soil texture. The results are compared with other machine learning algorithms to validate the degree of optimal outcomes.

Keywords: Soil fertility, deep learning, fertilizer, optimality, matching



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INTRODUCTION

Farming is turning smarter at recent times with the applications of machine learning to a greater extent. The primary objective of augmenting technology with farming is to increase agricultural productivity with minimum energy inputs. The different genres of machine learning algorithms are applied mainly to design optimal solutions to the issues of managing natural resources and maintaining soil fertility. The agricultural yield is primarily dependent on the fertility of the soil and this signifies the quality of the soil playing a key role in productivity. As the present environmental degradation causes the soil to lose its characteristics, the fertilizers are added as supplementary to balance the deficit of soil nutrients. However the choice of making suitable fertilizers remains as the major challenge of the farmers. The human centred decision making on fertilizer selection may not be precise at all instances as the intuition based decisions are subjective in nature. It is also quite difficult to decide on the features to be considered as inputs. As the prediction is purely dependent on the past data, the testing of data quality is significant. This has led to the transition towards a hybrid decision making system integrating the entities of both human and humanoid.

The entire universe is incorporating the elements of artificial intelligence in its functioning to become more robust and the agricultural sector is not an exception to it. Machine learning algorithms, the subset of artificial intelligence, finds several applications in making optimal decisions on soil fertility. Researchers have applied machine learning algorithms to investigate the characteristics of the soil and to make suitable predictions on soil fertility. Keerthan *et al* [1] applied Random forest algorithms for soil predictions, Benedet *et al* [2] used a combined approach of X- ray fluorescence and machine learning algorithms. Longchamps *et al* [3] used induced fluorescence. Wang [4] applied machine learning algorithms in exploring the factors contributing to the soil fertility.

Rose *et al* [5] applied machine learning algorithms in estimating the parameters affecting the soil fertility. Researchers such as Yadav *et al* [6] and Raut *et al* [7] applied machine learning and deep learning algorithms to recommend crops suiting to the soil fertility. Malik *et al* [8] compared the efficiency of the machine learning algorithms in analysing the soil fertility and crop recommendation. Swapna *et al* [9] estimated the soil nutrients with the assistance of ML based algorithms. Bhingarde *et al* [10] and Peneti *et al* [11] discussed about the applications of IoT and machine learning in detecting the properties of soil and crop plantations. Swetha *et al* [12] made an advanced analysis of the soil fertility. Chana *et al* [13] experimented real time crop prediction using IOT and ML algorithms. Varshitha *et al* [14] predicted the agricultural yield based on the soil fertility. Malamsha *et al* [15] presented a survey on the application of ML algorithms in assessing soil fertility.

The above mentioned contributions exhibit the intensive role of ML and deep learning algorithms in making predictions on the fertility of the soil, crop recommendation and profit yield. However few research gaps are identified, the algorithms are primarily applied to find an optimal match between soil fertility and crop plantation. The texture of the soil is explored using the algorithms. The optimal match between the soil fertility and the suitable fertilizers are neither estimated or predicted using the machine learning and deep learning algorithms. This has motivated the authors to develop a deep learning model to find an optimal match between soil quality and supplementary fertilizers. The model of this kind will be highly beneficial to the agriculturalists in suggesting suitable fertilizers to the farmers and henceforth the agricultural productivity shall be maximized.

The subsequent content is organized into distinct sections. Section 2 delves into a comprehensive literature review, exploring the various applications of deep learning algorithms in prediction. Following that, Section 3 provides a concise overview of the methodology employed in the creation of the feedforward neural network. Moving forward, Section 4 elaborates on the approach used to apply the model for predicting the optimal match between soil fertility and fertilizers. Subsequently, Section 5 delves into the results derived from the model. Finally, the concluding section wraps up the work, offering insights into future avenues for exploration.



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LITERATURE REVIEW

This section presents a brief description of deep learning methods and the applications of feed forward neural networks in specific. Derived from the structure and operation of the neural networks in the human brain, deep learning techniques represent a subset of machine learning methods. These approaches leverage artificial neural networks characterized by multiple layers, allowing them to glean intricate patterns and representations from large datasets. Deep neural networks, a pivotal element within the realm of deep learning, have demonstrated significant achievements across various domains, including image and speech recognition, natural language processing, and game playing. Their prowess lies in autonomously acquiring hierarchical features directly from raw data, obviating the necessity for manual feature extraction.

Deep learning commonly employs various architectures tailored to specific tasks, such as Convolutional Neural Networks (CNNs) for image-related endeavors, Recurrent Neural Networks (RNNs) for sequential data, and specialized variants like Long Short-Term Memory networks (LSTMs) designed to capture long-term dependencies. In the context of image datasets, CNNs are frequently employed, whereas numerical datasets often call for the use of feedforward neural networks, also referred to as multi-layer perceptrons. The term "deep learning" specifically characterizes neural networks with multiple layers, enabling the extraction of intricate patterns from data. In the case of feed forward neural networks, information flows unidirectionally—from input nodes, through any hidden layers, to output nodes—without the presence of cycles or loops in the network structure. Even though a single layer perceptron lacks the depth characteristic of deep learning, incorporating one or more hidden layers transforms it into a feed forward neural network, categorizing it as a deep learning method. Models like feed forward neural networks, within the realm of deep learning, possess the capability to discern complex patterns and representations within large and intricate datasets. Training these models involves optimization techniques such as gradient descent. Advancements like transfer learning and generative adversarial networks have further broadened the scope of deep learning, establishing it as a predominant force in contemporary artificial intelligence applications. Some of the recent contributions of feed forward neural networks are presented as follows in Table 1. From the above Table 1 it is very evident that the feed forward neural network are applied in making estimations, predictions and forecasting. It is also observed that these networks are more robust and optimal.

Methodology of Feed forward neural network

This section presents the key steps in training a feed forward neural network,

Initialization

The process begins by initializing the weights (W) and biases (b) of the neural network randomly. Proper initialization helps the network start learning meaningful patterns.

- The parameters representing the weights and biases in the initial hidden layer and the output layer are indicated as $W^{(1)}$ and $b^{(1)}$, $W^{(2)}$ and $b^{(2)}$ respectively.
- Initialization is typically done from a normal distribution with small variances.

Forward Propagation

During forward propagation, the input data (X) passes through the network, and activations are calculated using weighted sums and activation functions. This step computes the predicted output (\hat{Y}).

- $Z^{(1)} = X \times W^{(1)} + b^{(1)}$: Weighted sum in the first hidden layer.
- $A^{(1)} = \text{ReLU}(Z^{(1)})$: Activation using ReLU function in the first hidden layer.
- $Z^{(2)} = A^{(1)} \times W^{(2)} + b^{(2)}$: Weighted sum in the output layer.
- $\hat{Y} = Z^{(2)}$: Output prediction (for regression tasks, output layer can be linear).



**Hanna Grace et al.,****Loss Calculation**

The loss function measures the difference between predicted (\hat{Y}) and actual (Y) values. It quantifies how well the network is performing.

Loss = $\frac{1}{m} \sum_{i=1}^m (\hat{Y}_i - Y_i)^2$: Mean Squared Error (MSE) loss for regression tasks.

Back propagation

Back propagation computes the gradients of the loss concerning the network parameters, directing subsequent weight and bias updates.

- Gradients are determined through the application of the chain rule and derivatives of activation functions.
- The derivatives play a crucial role in adapting the weights and biases to minimize the loss function.

Gradient Descent

Gradient descent is an optimization algorithm used to minimize the loss by adjusting weights and biases iteratively.

- Weights and biases are updated using the calculated gradients and a learning rate (α).
- Iteratively refine parameters to approach the optimal values for minimal loss.

Iterative Training

The iterative cycle of forward propagation, loss computation, back propagation, and gradient descent is repeated to refine the parameters of the network. This process continues either for a predetermined number of iterations or until convergence, as parameters are adjusted to minimize the loss.

These fundamental steps, characterized by mathematical expressions and formulations, are essential in the training of a feed forward neural network. They showcase how the network learns from data, adapts its parameters, and reduces errors to enhance the accuracy of predictions. In practical applications, the computations involved in these steps are efficiently handled by deep learning frameworks, enabling the training of sophisticated neural networks on extensive datasets.

Application of Feed forward neural network in decision making on Fertilizer selection

In this section, the feed forward neural network is applied to find a suitable match between soil fertility and fertilizer selection. 200 sample data sets of soil characteristics are collected from various sources. The data on the soil attributes such as pH, organic matter, nitrogen, phosphorous, potassium, sand, silt, clay and moisture is considered as input features. Also the past data on the three fertilizers that are commonly applied are also taken into account. The sample data is presented in Table 2. On subjecting the data in the R environment and using the package of “neuralnet”, the following results are obtained. The diagrammatic representation of the neural network is presented in Fig.1.

DISCUSSIONS

To evaluate the performance of feed forward neural networks, we examine four key aspects: accuracy, precision, recall, and F-scores. Accuracy assesses the proportion of correctly classified instances relative to the total instances in a dataset, serving as a fundamental metric for overall model correctness. Precision measures the ratio of correctly predicted positive observations to the total predicted positive observations, with a focus on minimizing false positives—particularly crucial in scenarios where such errors result in significant costs. Recall calculates the ratio of correctly predicted positive observations to all observations in the actual class, playing a crucial role in situations where the concern is missing positive instances (false negatives). It emphasizes the need to avoid such errors. The F-Score, or F1 Score, combines precision and recall into a unified metric, striking a balance between the two. Computed as the harmonic mean of precision and recall, the F-Score provides a consolidated measure of a model's accuracy, particularly valuable when dealing with imbalanced class distributions. The values of the parameters determining the effectiveness of the multilayer perceptron are presented in Table 3. From table 2, it is very evident that the



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multilayer perceptron has high competency with respect to single layered neural network. On applying the multilayer perceptron, the prediction results are obtained for various input parameters. The efficiency of such feed forward networks in making optimal matching between the soil attributes are well articulated in Table 2. This algorithm shall be applied to different input features and on different data sets. The numerical input data is subjected to R programming environment and promising results are obtained. The similar decision making approach shall be applied to other agricultural problems.

CONCLUSION

In this research work, a multilayer perceptron model is developed to determine an optimal match between the soil fertility and the fertilizer. This decision making model is more robust and yield optimistic results. The aforementioned decision making problem shall be treated with other algorithms and this research work shall be extended by integrating with other algorithms to evolve a hybrid model to handle such agricultural problems. The outcomes of this research work shall be discussed under the dimensions of economic, social and environmental.

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Table 1 Applications of Feed forward network

Author & Year	Areas of Application
Ozanich et al (2020) [16]	Estimation of direction of arrival
Nguyen et al (2020) [17]	Prediction of later-age concrete compressive strength
Lee and Ha (2020) [18]	Estimation of temperature of permanent magnet synchronous machine
Luo et al (2020) [19]	Prediction of electricity consumption
Al-Majidi et al (2020) [20]	Prediction of maximum power point of a photovoltaic array
Aggarwal et al (2020) [21]	Prediction of DNA conductance
Yu et al (2020) [22]	Prediction of water resources
Belciug et al (2020) [23]	Diagnosis of cancer
Nguyen et al (2020) [24]	Prediction of load-bearing capacity
Harish et al (2020) [25]	Classification of internet traffic
Marso and Merouani (2020) [26]	Prediction of financial distress
Nasrudin et al (2020) [27]	Modelling of microwave pyrolysis
Haldorai and Ramu (2021) [28]	Classification of urban sustainability
Li and Wu (2021) [29]	Prediction of vehicle-bridge interaction system
Zhao et al (2021) [30]	Prediction of effluent total nitrogen
Ramli et al (2021) [31]	Development of intrusion detection system
Chen et al (2022) [32]	Detection of Atrial fibrillation
Marijanović et al (2022) [33]	Wound detection
Rodríguez et al (2022) [34]	Seismic assessment
Xie et al (2022) [35]	Prediction of effluent water quality
Chen et al (2023) [36]	Prediction of residual strength
Nie et al (2023) [37]	Prediction of carbon emission
Le et al (2023) [38]	Prediction of nuclear mass
Vitale et al (2023) [39]	Estimation of the basement depth





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Table 2 Sample Data

S.No	pH	Organic matter	nitrogen	Phosphorous	potassium	sand	silt	clay	moisture	Fertilizer Type
1	8	2.5	30	22	49	50	26	26	0.1	Fertilizer A
2	8	3	22	24	34	46	36	25	0.2	Fertilizer B
3	5	3	26	13	36	59	25	33	0.25	Fertilizer B
4	8	2	31	24	30	55	33	19	0.2	Fertilizer B
5	7	2	36	10	37	41	44	21	0.3	Fertilizer C
6	6	2	24	18	39	56	29	35	0.5	Fertilizer B
7	8	2	36	11	30	60	38	15	0.4	Fertilizer B
8	7	2	23	21	47	51	27	31	0.6	Fertilizer B
9	7	3	35	23	32	60	32	25	0.2	Fertilizer B
10	8	2	36	10	37	47	31	20	0.3	Fertilizer B
11	8	3	27	25	49	47	45	15	0.24	Fertilizer A
12	7	2	28	11	34	59	41	19	0.36	Fertilizer B
13	8	3	31	11	39	46	33	33	0.25	Fertilizer C
14	6	2	39	21	35	45	36	30	0.4	Fertilizer B
15	5	2	33	21	31	50	28	25	0.5	Fertilizer C

Table 3 Efficacy of Quality Parameters of Algorithms

Algorithms	Accuracy	Precision	Recall	F-scores
Multilayer perceptron	93%	91%	94%	91.02
Single-layer network	81%	80%	82%	82.04

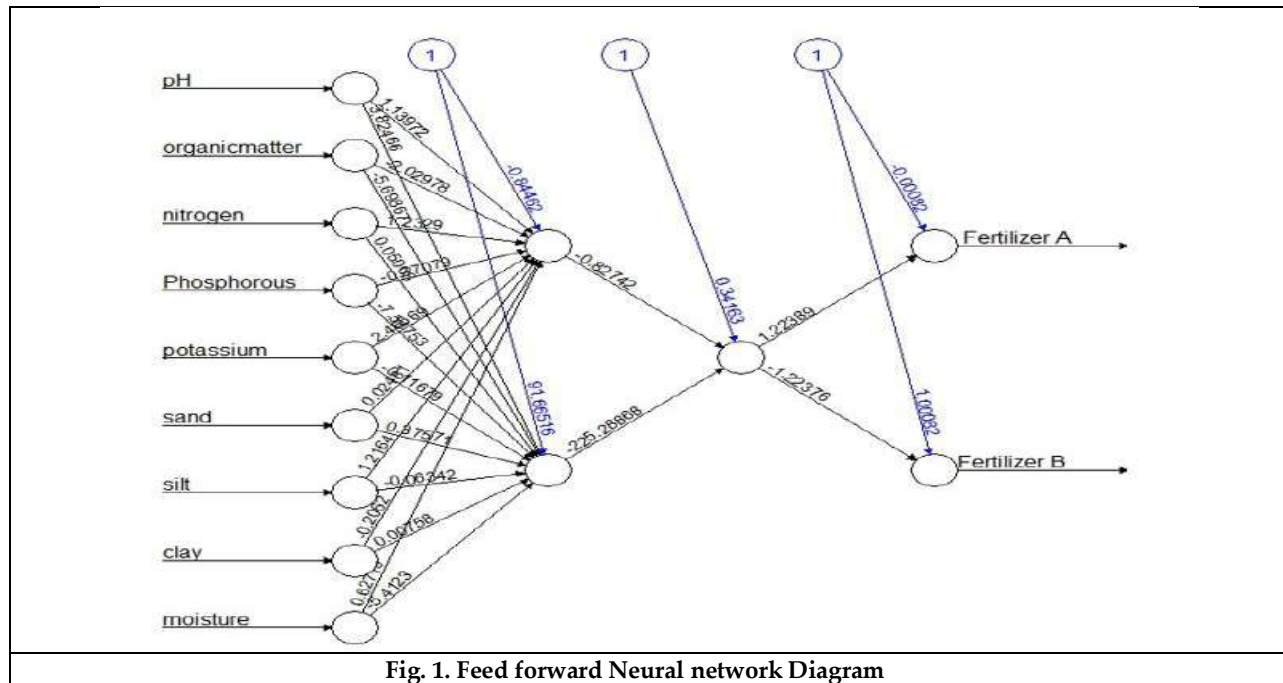


Fig. 1. Feed forward Neural network Diagram





RESEARCH ARTICLE

The Assessment of Women's Health-Related Quality of Life and Knowledge Gaps on Poly-Cystic Ovarian Syndrome (PCOS) has Implications for Better Self-Care and Educational Programs

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ABSTRACT

Women have a variety of health conditions that may result in a range of health-related issues. One of the main causes of delayed identification or inadequate disease self-management in such circumstances is ignorance. Furthermore, one of the biggest barriers to treating such conditions may be the ease or freedom with which one can speak or get knowledge. PCOS is a syndrome that affects women who are of reproductive years and has the potential to result in infertility. Patients may experience anxiety as a result of the condition developing at such a young age, overall PCOS has serious side effects that can negatively impact a person's lifestyle and general health. Consequently, it is imperative that women become more knowledgeable about the illness and how to manage it on their own. The aim of the investigation is to determine the degree of knowledge regarding PCOS and the differences in health-related quality of life (HRQoL) between the women in the group used as a control and those in the treatment group, who are between the generations of 18 and 49. The research was quantifiable along with comparable by design. The PCOS knowledge and Health Management Questionnaire was used in the study. Having 140 responders in the sample who had gone through participation assessment. Both psycho-social and physiological impacts diverged significantly comparing both of the groups. Perhaps as a result of their own experiences, patients who have been diagnosed as having PCOS typically understand this disorder well. In all categories, there is still a lack of knowledge regarding risk factors, signs, age categories most impacted by PCOS, hormonal changes, and hirsutism. Regarding PCOS, about



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half of the respondents had inadequate understanding and habits associated with health. Women who have been tested or suspect PCOS need to consult a doctor right away because getting medical care for PCOS shortly after diagnosis may enhance their standard of living. The creation and promotion of efficient strategies for raising education within women through the use of interaction and technological advances on the internet is necessary.

Keywords: health awareness, Polycystic Ovarian Syndrome, Hirsutism, obesity, menstrual irregularities

INTRODUCTION

Formerly being referred to as PCOS, polycystic ovarian syndrome, or PCOS for short, was known as "Stein-Leventhal syndrome" followed by polycystic ovary disease, or PCOD [1]. This constitutes a diverse hormonal along with biochemical illness that has a major impact on women who are fertile, subsequently is marked by cysts in the ovaries, oligo- or anovulation, and elevated testosterone levels [2-4]. Five to ten percent of women who are fertile are affected [5]. Although the exact cause of the condition remains unresolved, a growing body of data points to an array of biochemical and reproductive disorders that cause excessive levels of estrogen, testosterone and other hormonal disturbances [6]. Additionally, PCOS may result in a number of problems that have a significant negative impact on a woman's physical well-being as well as her quality of living [7]. A unanimous decision made at a workshop held in Rotterdam in 2003 under the sponsorship of the ESHRE/ASRM suggested that PCOS could potentially be evident when more than one out of three conditions were satisfied [8].

1. Anovulation or oligo-ovulation
2. Overindulgence in testosterone
3. USG reports polycystic ovaries.

Still, the majority of women along with girls are ignorant about the illness. Menstrual system illnesses and annoyances are typically ignored in semi-urban environments and are not looked into until the problem has gotten worse. The disease is becoming more prevalent as a result of modernization's effects on the surroundings and ways of lifestyle. Though, at this point, the majority of doctors' attention is directed toward managing particular PCOS-related signs or diseases, the threat of potential challenges, their incidence, and patient education remain misdirected. In the past few years, PCOS cases have increased by almost 30% in India. Being overweight, poor glucose tolerance, diabetes, particularly type 2 diabetes, and the syndrome of metabolic disorders are linked to PCOS in over 40% of instances [9]. Although the exact cause of PCOS is still unknown, the resistance to insulin is currently identified as an important cause. One might speculate how there is such a paucity of knowledge regarding PCOS given the high frequency of the condition, its both immediate and long-term effects on both mental and physical wellness, and its monetary burden for the medical service sector [10]. Given the signs, protracted course, and problems of the illness, it is imperative that medical professionals recognize the significant impact it has on patients' physical, mental, and social well-being. Furthermore, it's must be done to attend to the individuals' questions and knowledge demands because research has shown that a lack of information can have a detrimental impact on an individual's standard of living [6]. Research has shown how connecting with people, exchanging situations, along with getting quick access to knowledge and guidance all contribute to a better standard of living. Additionally, feeling knowledgeable boosts confidence as well as self-esteem [11]. Enhancing awareness is encouraged and supported by a number of research, despite the fact that the literature sources that are now available range greatly in their descriptions of the conscious approach and techniques. The process of raising knowledge was found to positively correlate both a reduction in anxiety as well as an improvement in the patient's comprehension of the illness, its progression, with how it's treated, leading to a better way of life and a more upbeat outlook [6]. The information on women's awareness of PCOS is, however, scant. Consequently, the goal of the research is to determine women's understanding and awareness of PCOS and female health-related behaviors [12].





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METHODOLOGY

Scholars often conduct studies to learn more about the underlying causes of PCOS. One of these investigations was conducted in Vadodara, India, and aimed to determine the influence of PCOS on participants' health-related quality of life (HRQoL). A total of 140 participants were enrolled in this research, comprising 30 healthy persons as the control group and 110 PCOS cases. The individuals that took part in the selection process ranged widely in age, from 14 to 40. Subjects must match the Rotterdam criteria for PCOS, which include having a minimum of a pair of the subsequent symptoms: excess androgen, ovulatory dysfunction, and medical or biochemical characteristics of polycystic ovary syndrome. After then, the subjects were asked to answer a survey regarding their HRQoL. The Government Primary and Tertiary Health Care facility in Vadodara city collaborated with us to collect the data for a period of three to five months, from July 2021 to November 2021. Through the use of an HRQoL questionnaire, the participants' emotional, mental, physical, and interpersonal wellbeing will be assessed. By examining how PCOS affects HRQoL, the project aims to provide a comprehensive understanding of the condition and have an impact on the development of medicines to improve the health outcomes of those who are affected.

Questionnaire

The self-report consumption and exercise examination (EEE) / health related quality of life questionnaire (HRQoL) is what the researchers want to use to gather data [14][13]. An accepted method for evaluating the effects of exercise and consumption patterns over the years across different facets of social, physiological, and mental health is the EEE questionnaire. The HRQoL questionnaire, which was utilized to evaluate how PCOS affected participants' health-related quality of life, has been included in the EEE. The PCOS Public Awareness Scale (11 questions) and symptoms or the impact of diet, exercise, and body weight on everyday living and acute medical state are included in the HRQoL questionnaire (44 questions). The purpose of these questions is to assess the participants' emotional, mental, and physical well-being. In order to find patterns and trends in the responses, the HRQoL questionnaire data was analyzed and plotted using software. By using this data, the researchers were able to pinpoint possible problem areas and create focused interventions to deal with them. Using this information, the researchers were able to pinpoint possible problem areas and create focused interventions to deal with them. The results of this study greatly advanced our knowledge of how PCOS impairs the quality of life for those affected and indirectly impacted the development of interventions aimed at improving these individuals' health. The following questions were included in the form utilized for this investigation (Table 1): The carefully crafted questionnaire has been developed in light of the potential signs of PCOS and other related issues. The survey asks about exercise level, age at menarche, duration and regularity of the menstrual cycle, the kind of menstrual bleeding, and presence or absence of acne, hirsutism, or dysmenorrhea. Girls with irregular periods, hirsutism, or both were considered to have a probable diagnosis of clinical PCOS. Menstrual irregularity was defined as girls reporting a menstrual period longer than 35 days or having varied or irregular cycles. Adolescent girls who presented with moderate to severe inflammatory acne, irregular menstruation, and/or undesired hair growth in a male-like pattern were suspected of having clinical hyperandrogenism.

RESULT AND DISCUSSION

PCOS Specific Symptoms and Parameters:

PCOS-related long-term problems impact various aspects of women's health-related quality of life (HRQOL) [15,16]. According to the study, adolescent women with PCOS had significantly lower HRQOL than controls who were in good condition. The survey's findings shed light on a number of variables and circumstances pertaining to PCOS (Polycystic Ovary Syndrome), which affects both patients and the control group. The replies showing the frequency of particular symptoms and concerns in the two groups are shown in the table.



**Janvika Varma et al.,****The hair Development**

One of the primary features of hyperandrogenism in PCOS is this. Between 60 and 80% of women with PCOS experience hirsutism[17, 18, 19, 20]. Understanding the pathogenesis of hirsutism in PCOS and classifying the severity of the anguish it causes for each individual are essential for choosing an appropriate course of action[21]. It is reported that the prevalence of hirsutism in PCOS could be between 70-80% as compared to prevalence of 4-11% for the same among women without PCOS[21]. Acne, androgenic alopecia, as well as hirsutism, are clinical manifestations of hyperandrogenism among women having PCOS [22]. The Ferriman-Gallwey (FG) score serves as a perceptual rating system that was developed by Ferriman and Gallwey to be used in clinical evaluations of hirsutism severity[23]. Menstrual abnormalities and metabolic comorbidities will dictate the overall tailored treatment plan for hirsutism in patients with PCOS [21, 24]. In comparison to the control group, the patients reported noticeably more instances of visible hair growth on their faces, chins, abdomens, and upper lips. Furthermore, a significant percentage of patients mentioned that their excessive hair growth made them feel less attractive and humiliated. Visible body hair development was seen in 26 out of 110 individuals, which is indicative of hirsutism, a typical sign of PCOS. Due to excessive hair growth, a significant proportion of patients (47 out of 110) experienced embarrassment, which may have an impact on their body image and self-esteem. The influence on self-perception and confidence was highlighted when 52 patients said that they felt less sexy as a result of their excessive hair growth. These results are consistent with the well-known hirsutism sign of PCOS, which is atypical hair development in places usually patterned for men.

The mental wellness

In comparison to the control group, patients showed greater prevalence rates of a variety of mental health problems. Anxiety, low self-esteem, feeling strange or different from other people, mood swings, irritation, tension, wrath, melancholy, and worry were some of these symptoms. Fifty-eight patients reported having anxiety, demonstrating the psychological toll that PCOS takes. Seventy-two patients out of a hundred reported having low self-esteem, which may have been impacted by problems with body image and other symptoms of PCOS. Perceptions of being strange (85 patients) and unique from others (87 patients) were prevalent, indicating the influence on interpersonal relationships and a sense of inclusion. In addition to these psychological symptoms, PCOS patients also frequently experienced tension, rage, despair, worry, and mood swings. These findings demonstrate how PCOS affects mental health and underline the necessity of both medical treatment and psychological care in addition to it.

The body weight

Polycystic Ovarian Syndrome is one condition linked to being overweight. As a result, PCOS development is influenced by both obesity and weight gain[21]. Obesity or over weightness affects 38%–88% of women with PCOS [25,26,27]. Obesity and PCOS genesis are both influenced by genetic factors [28,29,30]. However, there are additional ways in which PCOS might inhibit efforts to achieve sustained weight loss and promote further weight gain. Patients and the control group both mentioned difficulties controlling their weight. Patients did, however, report increased odds of being overweight, having trouble maintaining a desirable weight, feeling less attractive as a result of their weight problems, and having trouble managing their weight. These results highlight the influence of PCOS on body weight and body image issues, as PCOS is frequently linked to weight gain or difficulties decreasing weight. These results highlight the influence of PCOS on body weight and body image issues, as PCOS is frequently linked to weight gain or difficulties decreasing weight. The difficulties the 58 PCOS patients experienced managing their weight brought attention to the difficulties they encounter in keeping a healthy weight. A similar number of patients (59) had difficulty maintaining their ideal weight, showing the challenge of reaching weight goals. Significantly more patients (68 out of 110) said that their weight-related problems made them feel less attractive, which negatively affected their confidence and self-perception.



**Janvika Varma et al.,****Menstrual duration**

Oligo-ovulation and a prolonged interval between vaginal bleeding episodes were observed in around 85%–90% of women with PCOS [31, 32]. Hyperinsulinemia and irregular and prolonged menstrual periods are strongly correlated, according to a cohort research [33]. The prevalence of PCOS, dysmenorrhea, menorrhagia, amenorrhea, polymenorrhea, hypomenorrhea, and irregular menstrual cycle was found to be 49.13%, 52.60%, 12.17%, 0.43%, 7.82%, 2.17%, and 32.17%, respectively, among those who had previously obtained a diagnosis[34]. Compared to the control group, patients reported higher rates of menstrual abnormalities and associated complaints. 84 out of 100 patients expressed concern about irregular menstruation, which is indicative of the irregularities related to PCOS. PCOS patients frequently experienced symptoms such as menstrual cramps (110 patients), excessive menstrual bleeding (96 patients), abdominal bloating (97 patients), and menstrual periods with clots (94 patients). The disturbed hormonal balance associated with PCOS, which can cause irregular menstruation and related discomfort, is consistent with these findings.

Health and wellness

In comparison to the control group, PCOS patients reported a number of health-related issues (Table 2). Seventy-five patients reported feeling more hungry, which could be a factor in their inability to control their weight. A number of patients (76), had headaches (83), were fatigued (88), had back pain (95), and had sleeplessness. These symptoms show how PCOS affects the patients' general health and quality of life. The possible hormonal and metabolic imbalances associated with PCOS that may have an impact on general health and wellbeing are reflected in these symptoms. The information shows how PCOS significantly affects a patient's body weight, menstrual cycle, mental health, and general health, among other areas of their life. Among PCOS patients, excessive hair growth, psychological problems, trouble controlling weight, irregular menstruation, and related physical discomfort were common. Additionally, the survey's findings give medical professionals insightful information that helps them better comprehend the particular symptoms and worries that patients are experiencing. With this information, treatment strategies can be customized to address the psychological and physical issues related to PCOS, as well as appropriate support and counseling. Research that connected bipolar disorder to PCOS is also included in the article; however, it's probable that the connection resulted from both the disorder and specific treatments for the ailment. Particularly the use of valproate, a medication used to treat epilepsy and bipolar illness, has been connected to weight gain, oligomenorrhea, relative hyperandrogenism (excess testosterone production), and the prevalence of polycystic ovarian syndrome. The essay highlights the importance of considering the impact of drug use and mental disorders when managing PCOS overall, particularly for individuals who are already juggling the condition's complex and variable nature[35].

PCOS awareness in the patient and control groups

The information supplied shows the findings of a poll meant to gauge public knowledge of PCOS, or polycystic ovarian syndrome (figure 6). Two groups participated in the survey: PCOS sufferers and a control group. Fortunately, the serious effects of PCOS can be easily avoided with a prompt diagnosis; however, this is only achievable if newly diagnosed women are thoroughly informed on the condition[36]. The purpose of the first question was to find out how much each group knew about PCOS generally. The majority of respondents in both groups (Control: 80%; Patients: 85%) had heard of PCOS, according to the data, indicating a reasonable level of awareness among the general public. The purpose of the second question was to gauge how well they understood what PCOS is. The findings indicate that a greater percentage of patients (44%) than those in the control group (25%) were able to define PCOS accurately. But there's certainly space for growth when it comes to educating people on the specifics of the illness. The next one tried to investigate respondents' perspectives about PCOS. The findings show that, in comparison to the control group (15), a larger proportion of patients (44) perceived to have PCOS. Comparison with the control group 15%, the results show that a larger proportion of patients 44% perceived to have PCOS. According to this research, people who have been diagnosed with PCOS can have a deeper comprehension or firsthand knowledge of the illness. The following question sought to ascertain knowledge of the body component impacted by PCOS. The findings demonstrate that a greater percentage of patients (64%) than those in the control group (40%) were able to identify the afflicted body area. It was remarkable, therefore, that a sizable portion of



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respondents in both groups were unaware of this PCOS feature. Additionally, the question designed to gauge comprehension of the phrase "polycystic ovary." Results point to a deficiency in awareness or understanding in this area, as only 14% of respondents in the patient group and 10% in the control group properly understood the concept. The purpose of the following inquiry was to find out if respondents knew of anyone in their social circle who had PCOS. According to the data, more patients (39%) than members of the control group (25%) knew someone who had PCOS. This research implies that a deeper comprehension of PCOS may result from individual encounters or relationships with the illness. The purpose of the next question was to gauge respondents' understanding of the risk factors connected to PCOS. Comparing the patients (27) to the control group (5), the results show that a greater percentage of the former group had some awareness of the risk factors. On the other hand, it seems that the two groups have a fairly low total awareness. There was also research done on the signs of PCOS knowledge. In contrast to the control group (10%), a greater percentage of patients (33%) had knowledge of the symptoms, according to the data. In both categories, there is still, nevertheless, a marked lack of knowledge regarding the symptoms. The next question will test your understanding of the age range that is most impacted by PCOS. The findings indicate that more patients 20%(20), on the other than members of the control group 5% correctly identified the age group most affected. Nonetheless, in both categories there is comparatively little general awareness of this component of PCOS. An additional question was designed to gauge knowledge on the hormonal alterations linked to PCOS.

According to the findings, just 14 out of the patients were able to accurately identify the rise in hormone levels, although no res-ponders in the control group were able to do so. This result emphasizes how little is known about the hormonal components of PCOS. The goal of the final question is to gauge how well you grasp the definition of "hirsutism," which is the term for excessive hair development. The findings indicate that a relatively modest percentage of respondents in both categories were able to appropriately define hirsutism. Figure 1 shows the correlation between the patient and control data, with an R2 value of 0.85. The general public needs to be more informed and aware of PCOS, according to the survey's overall findings. Despite having a greater awareness of the issue overall, patients with PCOS still had certain misconceptions. The population as a whole was represented by the control group, which had poorer awareness and knowledge of PCOS. These results highlight the value of public education and awareness efforts in improving knowledge, early diagnosis, and effective PCOS care. The majority of participants in the research study had very little knowledge of PCOS and did not rely much on media sources such as TV and newspapers. Books, doctors, and friends provided just the right amount of information for a few of these people. These findings were likewise associated with a study in which 80 (100) percent of individuals had no prior knowledge of PCOS[37]. In another poll, 28% of respondents said they were unaware about PCOS, while 19% said they had heard about it from coworkers and 3.5 percent via newspapers[38]. It makes sense that ambiguity surrounds therapy given the challenges in diagnosing PCOS [39]. According to the data collected, women in the National Capital Region (NCR) aged 18 to 49 who were diagnosed with Polycystic Ovarian Syndrome (PCOS) had a significantly higher health-related quality of life (HRQoL) than those who were not diagnosed with PCOS but had the symptoms[40].

CONCLUSION

The results showed that the patients in the Vadodara, Gujarat, age range of 18 to 49 and the group control had significantly different health-related quality of life (HRQoL). Although there is a fair level of general awareness, both groups have comparatively little understanding of the intricacies of PCOS, such as its definition and the body part it affects. Due to their personal experiences or ties to PCOS, patients with the disorder appear to have a better understanding of it. For girls who exhibit symptoms, a prompt PCOS diagnosis is crucial to starting the right course of treatment. More has to be done to raise awareness of PCOS symptoms and to encourage people to report symptoms as soon as they appear, such as during irregular menstruation. Doctors must also be vigilant in identifying and reporting any beginning signs of PCOS. Youth educational initiatives should include health awareness and PCOS evaluation. An assessment of target groups based on a basic menstrual history could identify potential PCOS in young adolescents and enable timely, suitable management.





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Janvika Varma *et al.*,**Table 1: List of questions included in survey form**

Sakalchand Patel University, Visnagar	
Questionnaire form for PCOS Patients	
1) Registration No:	
2) Patient's Name:	
3) Variables in patients with symptoms of PCOS	
	Symptoms
1	Over weight
2	Growth of visible hair on face
3	Difficulties staying at a weight you would like
4	Trouble dealing with weight
5	Growth of visible hair on chin
6	Growth of visible hair on the upper lip
7	Growth of visible hair on body
8	Tire easily
9	Irregular menstrual periods
10	Headaches
11	Abdominal bloating
12	Growth of visible hair on abdomen
13	Increased appetite
14	Back pain
15	Menstrual cramps
16	Heavy menstrual bleeding
17	Menstrual periods with clots
18	Frustration because the attempt to lose weight was not successful
19	Embarrassed about excessive hair growth
20	Fell lack of control over the situation
21	Depressed
22	Worried
23	Moody
24	Low self-esteem
25	Being self-conscious all the time
26	Fear of getting cancer
27	Feeling blue
28	Feeling different from others
29	Scared about the future





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30	Losing temper easily
31	Irritated by other people
32	Tense
33	Angry
34	Anxiety
35	Tearful
36	Get upset easily
37	Worry that don't have menstruation
38	Frustration because other don't understand condition
39	Insomnia
40	Feeling weird
41	Like to be by self
42	Don't feel sexy because of overweight
43	Don't feel sexy because of excessive hair growth
44	Feel like it will take a long time to reach goals in life
4) PCOS Public Awareness Scale	
1	Have you ever heard about PCOS?
2	What does polycystic ovary syndrome refer to?
3	What is your perception of PCOS?
4	Which body part gets affected in PCOS?
5	What is the meaning of polycystic ovary?
6	Do you know about the risk factors of PCOS?
7	Do you know about the symptoms of PCOS?
8	Is there anyone around you who is suffering from PCOS?
9	What is the age group most affected by PCOS?
10	In PCOS, the level of which hormone increases in women?
11	Do you know what is meant by hirsutism?

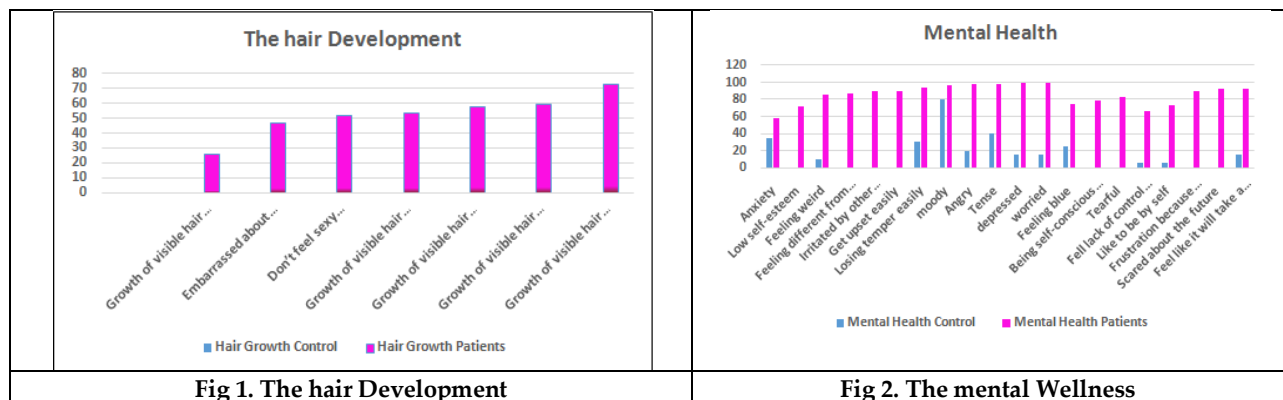


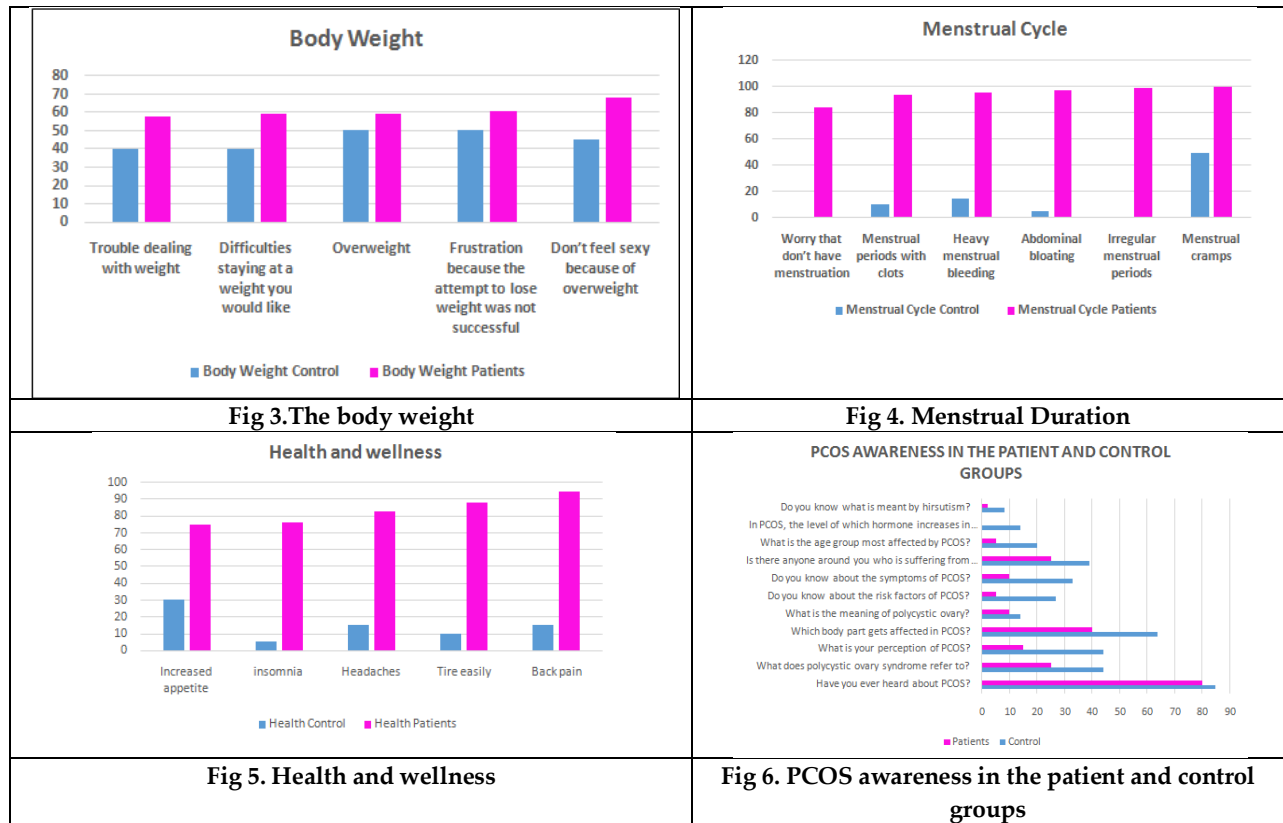
Fig 1. The hair Development

Fig 2. The mental Wellness





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Constraints Faced by the Farmers in Utilizing Mobile App (Pachathundu App) in Dindigul District of Tamil Nadu State

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ABSTRACT

As the pachathundu app was launched recently, it was felt necessary to study the constraints faced by the farmers during utilization so as to redesign the app more suitable to the needs of the farmers. The study was taken up in five selected villages in Nilakottai Block of Dindigul District of Tamil Nadu. A fixed sample size of 120 respondents was selected by proportionate random sampling technique. The data were collected from the respondents with the help of a well-structured and pre-tested interview schedule. The required data were collected by personal interview schedule by utilizing a well-structured and pre-tested interview schedule. The collected data were interpreted by using appropriate statistical tools. It could be interpreted one-third of the respondents regularly faced the technological constraints like low network connectivity and lack of update information. Economic constraints faced by half of the respondents viz., costly additional service and high cost of mobile set. Some of the respondents were facing the social constraints viz., low literacy and lack of IT literacy. One-fourth of the respondents were expressed psychological constraints viz., lack of self confidence and lack of technical know-how. One-third of the respondents faced content related constraints viz., difficulty in understanding due to brief content and content not updated.

Keywords : Constraints, Economic constraints, Mobile app, Pachathundu app, IT literacy .





INTRODUCTION

The mobile app is software programs developed for mobile devices such as android mobile and smartphones. The MSP (Mobile Service Providers) help them to associated (for example, Verizon, AT&T, T-Mobile, etc.), but many more apps are available through device- specific app stores mobile applications frequently serve to provide users with similar services to those accessed on PCs. Apps due to the latest smartphone with including the functionality as PCs. In 2009, newer smartphones could be nicknamed "app phones" to distinguish them from earlier less-sophisticated smartphones (Pogue, David, 2009). Access to information on new varieties, inputs such as seed, fertilizers, machinery, price information, weather, pests and diseases, nutrient management at the right time can help farmers get access to crucial information to support activities from production to marketing. There is an increasing number of mobile apps providing access to agriculture and allied sector information (Colle, 2011). The farmer needs two-way-communication and dynamic information for day- to-day farming. Farmers need timely information in response to their specific needs. There are mobile applications that provide latest agricultural information about trends, equipment, technologies and methods being used, help identify pests and diseases, provide real-time data about weather, early warnings about storms, local markets offering best prices, seeds, fertilizers etc. In addition, farmers can also interact and get guidance from agriculture experts across the country via the apps. These apps help in providing market information, facilitating market links, providing access to extension services, farm related information etc. Government of India has launched a number of web and mobile based applications for dissemination of information on agriculture related activities, free of cost, for the benefit of farmers (Sudhakar, B. 2019)..

Pachathundu app (private app) was selected for study with following reasons as farmers can get complete information on real time basis from pachathundu mobile application which provides the farmer to get information all schemes components and subsidy pattern of assistance, register him to avail scheme benefits on priority basis. Pachathundu is the Application which was launched by the Individual organization named as YTV Farmer Seva Kendra. Application was available in android and can be downloaded from the google play store. Objective of the application is to empower farmers with accurate crop production and crop protection technique and other related agricultural input decision making process by them.

Objective of the study

To study the constraints faced by the farmers during the utilization of pachathundu app.

REVIEW OF LITERATURE

Kavipriya (2020) revealed that the major constraints experienced by majority of the uzHAVAN app users were inadequate information about horticultural crops (61.67 per cent), difficulty in uploading images (54.17 per cent) difficult to contact the product sellers and customer hiring centers (4.17 per cent), delayed response for feedback (40.00 per cent) and poor network connectivity (30.00 per cent). Abdulladhi *et al.*, (2021) revealed that the major constraints experienced by majority of the mobile phone app users are no power supply (94.50 per cent), lack of access to network (89.60 per cent), action of association/farmer groups (85.20 per cent) and problem of updating apps (75.10 per cent) respectively. Gayathri (2021) reported that majority of the respondents in usage of uzHAVAN app were inadequate information about horticultural crops (65.83 per cent) and difficulty in uploading images (66.67 per cent). The constraints viz., difficult to contact the product sellers and custom hiring centres (45.83 per cent), delayed response for feedback (43.33 per cent) and poor network connectivity (40.00 per cent) were the constraints faced by two-fifths of the respondents. One-fourth of the respondents faced lack of precise information (26.67 per cent) and difficulty in operating the app as their constraints. Sudharsan (2022) in his study on effectiveness and utilization of web and mobile based agricultural information deliver system among the farmers in Tiruvannamalai District of Tamil Nadu revealed that the major constraints are experienced by the respondents are poor network connectivity



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(63.30 per cent), lack of updated information (46.70 per cent), low literacy (30.00 per cent) and high cost of internet service (21.70 pr cent).

RESEARCH METHODOLOGY

Dindigul district in Tamil Nadu was purposively selected for this study. Dindigul district was stand second in the number of registered users on the pachathundu app among all the districts of Tamilnadu. Dindigul district has fourteen blocks namely Athoor, Batlagundu, Gujiliampari, Kodaikanal, Palani, Dindigul, Reddiarchatram, Sanarpatti, Thoppampatty, Vadamadurai, Ottanchatram, Natham, Nilakottai and Vedsandur. Among these Nilakottai block was selected based on maximum number of pachathundu app registered users among the blocks. In Nilakottai block, totally 10 villages the farmers are using pachathundu app. Out of 10 villages five villages namely Batlagundu, Silukuvarpatti, Rengappanaickanpatti, Viruveedu and Viralipatty were selected based on the maximum number of pachathundu app registered users in the villages. A sample size of 120 respondents was fixed for this study considering the limitations of time and other resources. All the 120 respondents were identified from selected five villages by using the proportionate random sampling technique. Based on the experience of the researcher coupled with discussion with the mobile app user and extension functionaries, various constraints faced by the respondents in accessing the information through mobile app were enumerated. In order of the constraints for the mobile app, five dimensions of constraints were analyzed through a rating scale developed for the purpose, which contains a set of statements in five dimensions viz., (i) Technological constraints, (ii) Economical constraints, (iii) Social constraints (iv) Psychological constraints and (v) Content related constraints. The respondents were asked to indicate the constraints. The frequency of respondents indicating each of the constraint was found out and expressed in percentage.

RESULTS AND DISCUSSION

It could be seen from Table 1 that constraints faced by farmers in utilizing the pachathundu app were divided in to technological constraints, economical constraints, social constraints, psychological constraints and content related constraints were discussed in this section.

Technological constraints

The various sub-items under technological constraints were presented in Table 1. One third of the respondents (34.16 per cent) expressed as low network connectivity followed by lack of update information (33.33 per cent), line congestion and busy network (15.83 per cent) and can't send SMS message (12.50 per cent). Farmers highlighted that the network connectivity was very slow and had limited access to internet networks. Few farmers don't know to download the apps and don't know to use the app. This finding is in line with the findings of Vinoth (2020).

Economical constraints

The various sub-items under economic constraints were presented in Table 1 that half of the respondents (50.83 per cent) were facing the constraints of costly additional service followed by high cost of mobile set (36.66 per cent), high cost of internet connection (29.16 per cent) and poor finance (24.16 per cent). In the economic constraints, high cost for additional service was found to be the most serious constraints. The farmers reported that the additional services such as wifi, android phones and the data connectivity charges are very high in cost. Some of them are poor and they can't affordable to buy an android phone. This finding is support with the findings of Kavipriya (2020).

Social constraints

Among the sub-items under social constraints were presented in Table 1 that 29.16 per cent of respondents faced the social constraints were low literacy followed by lack of IT literacy (27.50 per cent) and lack of skill (15.83 per cent). Hence, the pachathundu app service provider should work out strategies to develop content in local language with



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various forms of texts, audio and video etc, to access by the low literacy farmers. This finding is in line with the findings of Kailash *et al.*, (2017).

Psychological constraints

Among the sub-items under psychological constraints were presented in Table 1. One- fourth of the respondents were facing constraints as lack of self confidence (24.16 per cent) followed by lack of technical know-how (17.50 per cent) and mindset of users (15.83 per cent). Some of the farmers opined that need of training on usage of pachathundu app in the study area to rectify the psychological constraints. This finding is in accordance with the findings of Sudharsan (2022).

Content related constraints

Among the sub-items under content related constraints were presented in Table 1 that 37.50 per cent of respondents were difficult to understand the brief content followed by content not updated (34.16 per cent), incomplete content (23.33 per cent) and misinformation (20.83 per cent). It could be inferred that difficulty to understanding the brief content and content not updated as the most important constraints. Hence, the pachathundu app service provider should work out strategies to develop content by user friendly with various forms of texts, audio and video etc. Few farmers opined that some of the information shared through pachathundu app is in incomplete content of videos. Some information which is shared also misinformation. This finding is support with the findings of Yuvraj (2019).

CONCLUSION

There is need to strengthen the policy for developing the skill for appropriate handling and utilization of pachathundu app through several training programmes for stabilizing the agricultural system on digitized platform. It is envisaged that the results of the study would be useful to the policy makers and decision makers, development planners, government and non-governmental organizations who are concerned with the promotion of pachathundu app.

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Table 1. Distribution of respondents according to their constraints faced during utilizing the pachathundu app (Multiple response)

S.No.	Constraints	Number	Per cent
I	Technological constraints		
1.	Low network connectivity	41	34.16
2.	Lack of updated information	40	33.33
3.	Line congestion and busy network	19	15.83
4.	Call cut	17	14.16
5.	Can't send SMS	15	12.5
II	Economical constraints		
1.	Costly additional service	61	50.83
2.	High cost of mobile set	44	36.66
3.	High cost of internet connection	35	29.16
4.	Poor finance	29	24.16
III	Social constraints		
1.	Low literacy	35	29.16
2.	Lack of IT literacy	33	27.5
3.	Lack of skill	19	15.83
IV	Psychological constraints		
1.	Lack of self confidence	29	24.16
2.	Lack of technical know-how	21	17.5
3.	Mindset of users	19	15.83
V	Content related constraints		
1.	Difficulty in understanding due to brief content	45	37.5
2.	Content not updated	41	34.16
3.	Incomplete content	28	23.33
4.	Misinformation	25	20.83





Quality Improvement using Six-Sigma in Automotive Industry

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ABSTRACT

Defect parts per million opportunities play an important role for the improvement of productivity and improve the finance of the company in all aspects. The objectives of this case study are to study and evaluate processes of the case organization, to find out current sigma level and to improve existing sigma level through productivity improvement using SIX SIGMA level for injection moulding machine Sigma level had been calculated and given suggestions for improvement using some statistics quality control (SQC) tools like cause and effect diagram and control charts. In this case study, it is tried to optimize the moulding process in order to reduce the moulding defects like shrinkage using Taguchi's experimental design and analysis of variance (ANOVA) methods. In this study, Grey relational analysis (GRA) is used to filter the issue and is verified. The input variables are obtained using ANOVA method. By using this method, it has been possible to improve productivity by reducing defect rate. This research work has been carried out in an auto ancillary company to improve its productivity and quality. Single machine used in this study, obtained result horizontally deployed to all machines. By implementing Six-sigma a perfect synchronization among cost, quality, production time and control time will be observed. After implementation of the proposed method lowering the process capability index CPL for over shrinkage of PP material has been improved from 8.0 to 5.3, process mean decreased from 0.1015 to 0.0615. SIX SIGMA level has been improved from 2.38 σ standard to 5.18 σ standard. This work shows that process was improved closer to six sigma standard by changing the processing conditions only without any radical change in the part design, mould design, and machine performance.

Keywords: Six sigma, quality improvement, operations Management. Continuous improvement





INTRODUCTION

Advanced technology improvement and increased customer demands increased the competition in the current automobile market. Endeavours in reducing inventory in the context of operation management, are often related to reducing defect parts during the injection moulding process. Injection moulding process is the most cost-effective production process for producing complex large trim parts in large quantities. Quality is often defined imprecisely in textbooks in terms of a subjectively assessed performance level (P) of the unit in question and the expectations (E) that customers have for that unit. Formula for quality (Q) is: $Q = \frac{P}{E}$. The quality of plastic parts depends on the part design, mould design, machine performance and process conditions. During production, quality characteristics may deviate due to drifting or shifting of processing conditions caused by machine wear, environmental changes and operator fatigue. Six Sigma have been continuous improvement tools that manufacturers have been using for over 20 years. Six Sigma (6σ) is a set of techniques and tools for process improvement. It was introduced by engineers Bill Smith & Mikel J Harry while working at Motorola in 1986. Jack Welch made it central to his business strategy at General Electric in 1995. It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, mainly empirical, statistical methods, and creates a special infrastructure of people within the organization who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has specific value targets like reducing the process cycle time, pollution reduction, costs reduction, increasing customer satisfaction, and profits increase.

The term Six Sigma originated from terminology associated with statistical modelling of manufacturing processes. The maturity of a manufacturing process can be described by a sigma rating indicating its yield or the percentage of defect-free products it creates. A six sigma process is one in which 99.99966% of all opportunities to produce some feature of a part are statistically expected to be free of defects of 3.4 defective features per million opportunities. Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a by-word for the management and engineering practices used to achieve it. The term "six sigma" comes from statistics and is used in SQC, which evaluates process capability. Originally, it is referred to the ability of manufacturing processes to produce a very high proportion of output within specification. Processes that operate with "six sigma quality" over the short term are assumed to produce long-term defect levels below 3.4 defects per million opportunities (DPMO). Six Sigma's focus is on eliminating defects and reducing variability. This case study is aimed at optimizing the moulding parameters for the automotive bumper which is made from TPO material which is engineered for PP. In this paper we have considered the process parameter such as melt temperature, injection pressure, holding pressure and cooling time. Signal-to-noise ratio is being used to accomplish the ideal set of process parameters.

LITERATURE REVIEW

Though Fredrick Taylor, Walter Shewhart and Henry Ford played a great role in the evolution of six-sigma in the early twentieth century, it is Bill Smith, Vice President of Motorola Corporation, who is considered as the Father of Six-sigma. Fredrick Taylor came up with the methodology of breaking systems into subsystems in order to increase the efficiency of manufacturing process. Henry Ford followed his four principles, namely continuous flow, interchangeable parts, division of labor and reduction of wasted effort, in order to end up in an affordable priced automobile. The development of control charts by Walter Shewhart laid the base for statistical methods to measure the variability and quality of various processes. Six Sigma began in 1986 as a statistically based method to reduce variation in electronic manufacturing processes in Motorola Inc. in the USA. It is developed by Bill Smith at Motorola, later it was adopted by General Electrics (GE) and Allied Signals, where it was initiated by Jack Welch[1]. The numerical goal of Six Sigma is reducing defects to less than 3.4 parts per million (PPM) also known as 'Defects Per Million Opportunities' (DPMO), reducing cycle time and reducing costs dramatically which impacts the bottom line[2]. Six Sigma is a data-driven process improvement methodology used to make the process stable, outputs





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predictable and improve process capability. Six Sigma approach is a continuous improvement strategy that is mainly focused on customer satisfaction[3]. Six Sigma has two key methodologies, each consisting of five phases: DMAIC (define, measure, analyse, improve, control) and DMADV (define, measure, analyse, design, verify) The first methodology is used for existing processes, while the second is used to designing new processes[4] The DMAIC approach of Six Sigma was applied to reduce the rejection rate of plastic moulded parts[5]. Six Sigma improves efficiency and quality across industries through data-driven methods. By using statistical analysis, organizations can identify and eliminate defects, optimizing performance and enhancing customer satisfaction. Adopting Six Sigma as a continuous improvement framework offers strategic benefits for diverse sectors[6]. Pande PS, Neuman RP and Cavanagh RR provides insights, practical examples, and strategies for businesses aiming to enhance operational efficiency through the data-driven Six Sigma approach. It emphasizes minimizing defects and process variations to achieve operational excellence and boost customer satisfaction[7]. Koch PN, Yang RJ, Gu L. studied on how to improve design robustness and reliability using Six Sigma principles. The paper likely contributes to integrating Six Sigma with robust optimization for more effective and reliable engineering designs[8]. Lo W, Tsai K, Hsieh C studied on using Six Sigma to improve the surface precision of optical lenses in injection molding.

The abstract may discuss challenges, introduce Six Sigma as the methodology, and mention key findings or improvements in the injection-molding process for optical lenses[9]. Das SK, Hughes M study helps to boost recycling efforts, determining the true recycling rate using Six Sigma statistical techniques, Implementation of recycling bins to enhance the recycling rate, seeks to understand and reverse the declining aluminum recycling rate, paving the way for a national effort to increase recycling[10]. Goffnett SP explores Six Sigma, portraying it as a versatile metric, mindset, and strategic methodology for process improvement. It acknowledges both strengths and weaknesses, highlighting the decade-long growth and financial impact of Six Sigma, emphasizing the need for a well-trained workforce. The study underlines the creation of roles like Black Belts and calls for further investigation into Six Sigma's impact on industry and academia[11]. Wipro Technologies successfully implemented Six Sigma for business improvement, achieving significant gains in efficiency and cost savings. The initiative, led by over 200 certified consultants, focused on reducing defects, improving timeliness, and enhancing productivity. Wipro transitioned from project-oriented to sustaining culture, bringing about a 250% increase in data transfer efficiency. The company aims to continue its commitment to Six Sigma, ensuring continuous improvement and making quality the top priority for all employees. Analysts recognize Wipro's success in customer satisfaction, internal performance, and shareowner value[12]. Chakravorty SS studied the failures of Six Sigma initiatives. The study proposes an escalation model to understand the factors contributing to these failures[13] Safwat T, Ezzat A study presents a Six Sigma approach to reduce scrap rates in a plastic injection molding plant, using NATPACK Co. as a case study. The Six Sigma DMAIC methodology, including tools like SIPOC and P-control charts, was applied to analyze and improve the injection molding process. The study compared average scrap rates before and after implementing changes to showcase enhanced efficiency[14].

SIX SIGMA

Gutiérrez Pulido H, de la Vara Salazar R have highlighted that Six Sigma Methodology is a customer focused continuous improvement strategy that minimizes defects and variation towards an achievement of 3.4 defects per million opportunities in product design, production, and administrative process. [15] states that Six Sigma is a strategy of continuous improvement of the organization to find and eliminate the causes of the errors, defects and delays in business organization process. Six- Sigma is a statistical measurement of only 3.4 defects per million. Six-Sigma is a management philosophy focused on eliminating mistakes, waste and rework. It establishes a measurable status to achieve and embodies a strategic problem-solving method to increase customer, satisfaction and dramatically reduce cost and increase profits. Six-Sigma gives discipline, structure and a foundation for solid decision making based on simple statistics.





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SIGMA LEVEL TABLE

The table-1 gives long-term DPMO values corresponding to various short-term sigma levels. These figures assume that the process mean will shift by 1.5 sigma towards the side with the critical specification limit. In other words, they assume that after the initial study determining the short-term sigma level, the long-term Cpk value will turn out to be 0.5 less than the short-term Cpk value. So, for example, the DPMO FIGURE-1 given for 1 sigma assumes that the long-term process mean will be 0.5 sigma beyond the specification limit (Cpk = -0.17), rather than 1 sigma within it, as it was in the short-term study (Cpk = 0.33). Note that the defect percentages indicate only defects exceeding the specification limit to which the process mean is nearest. Defects beyond the far specification limit are not included in the percentage. The formula used here to calculate the DPMO is given in eqn(1).

$$DPMO = 1,000,000 \cdot (1 - \phi(\text{level} - 1.5)) \text{-----} \quad \text{Eqn(1)}$$

IMPLEMENTATION OF THE SIX SIGMA

SIX SIGMA can be implemented in two ways. One is the Tool based implementation focuses on “the mechanics of tool execution, as opposed to when and how a tool should be implemented and integrated with other tools.” Another is the Project-based implementation which involves tools being “taught and then applied to projects that are defined before training session begins.” The Six Sigma methodology is conducted by a team of people in five roles. The team is led by the quality leader/manager, who is responsible for representing the customer’s needs. Masters in Black Belts are responsible for specific areas or functions of a business, such as human resources and work closely with the Process Owners, who are individuals responsible for a specific process. Black Belts lead the quality projects and work full time with the company until they are complete. They also train the Green Belts, who are company employees trained in Six Sigma.

OBJECTIVES OF THE STUDY

Objective of this study is to identify reduce or eliminate all kinds of waste and defects using Six Sigma in the injection moulding machine in order reduce the cost and increase the productivity. To study the existing system and determine the level of wastes like the extent of material reject rates, idle times, levels of inventory, ways of processing and producing the products, over production rate. To identify the causes of defects and to measure them to improve the sigma level of the company by reducing DPMO by 50% in a year. In this study, DMAIC methodology was used to improve the exiting process. DMAIC (Define-Measure-Analyse- Improve-control) is a five-step approach that utilizes different Six-Sigma tools to generate ideas, collect and measure data, analyse and come up with improvement plans to improve the process under study. DMAIC methodology consists of the following five steps.

Measure Phase and Tool

Measure is the second step of the Six Sigma methodology and is denoted by the capital letter M. The modes of identification and solution generation may be triggered on a small scale as well. FMEA, MSA and particularly Gage R&R are tools that serve largely in a verification capacity, which fall into the problem identification and data management stages. Moulding process is explained in the below FIGURE-2

Improve

The team then enters the improve (I) step. Here a team would brainstorm to come up with counter measures and lasting process improvements that addresses validated root causes. The tool most preferred for this process is the affinity diagram, which is a brainstorming technique where a topic or issue is presented to a small team who then quickly list ideas or solutions. The team should narrow the list to one or two potential improvements that are step deliverables for small- should be selected based on probability of success, time to execute, impact on resources, and cost. If newly gathered data indicates the small-scale implementation is a legitimate success, teams should proceed to full-scale implementation.

Control

The final step for at least the black belt and many of the team members is control, which is signified by the capital letter C. At this point devices should be put in place to give early signals when a process is heading out of control.





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Teams may develop, Poka-yokes or mistake proof devices that utilizes light, sound, logic programming, or no-go design to help control a process. The ultimate goal for this step is to reduce variation by controlling X's (i.e., the inputs) and monitoring the Y's (i.e., the outputs). Tool kits which can be used in five phase of DMAIC as shown in FIGURE 4. In GRA, the function of variables is ignored if the response variable or standard value is high. S/N ratios are normalized between zero and one. Here we see larger the S/N ratio, better the experimental run, larger-the-better normalization was adopted using Eq. (2). Then the normalized S/N ratio x_{ij} can be expressed as shown in Table 2.

$$x_{ij} = \frac{y_{ij} - \min_j y_{ij}}{\max_j y_{ij} - \min_j y_{ij}} \quad \text{----- Eq(2)}$$

Where, y_{ij} is the S/N ratio of the i^{th} will track for the j^{th} response variable. In this the larger normalised results which are obtained gives better consistency and considered to be in par with the experimental outcome. Grey relational coefficient (GRC) on all experiments is carried on the optimal and actual outcome. GRC (ξ_{ij}) is shown as:

$$\xi_{ij} = \frac{\min_i \min_j |x_i^0 - x_{ij}| + \zeta \max_i \max_j |x_i^0 - x_{ij}|}{|x_i^0 - x_{ij}| + \zeta \max_i \max_j |x_i^0 - x_{ij}|} \quad \text{-----Eq(3)}$$

Where x_i^0 represents the best normalized results for i^{th} response variable ζ is the distinguishing coefficient values will be lying between 0 and 1 but always set at 0.5. GRCs has been done for this experimental study and being represented in FIGURE- 4. For our understanding GRC is being conducted on each experimental process and it is tabulated by using the individual response variable which is represented in the Eq. (4). If the value of the GRC is high it is seen that the experimental run is vital.

$$\gamma_i = \frac{1}{n} \sum_{j=1}^n w_j \xi_{ij} \quad \text{Where} \quad \sum_{j=1}^n w_j = 1, \quad \text{-----Eq(4)}$$

Where γ_i is the GRC for the i^{th} experiment, n = response variables, w_j = weighting value of the j^{th} response variable. Using Eq. (4), GRCs and GRGs values in Table 3 have been arrived by calculating and symbolized. Optimisation design is always done on single relational parameters than on complex numerous response parameters. GRC is calculated for the every moulding parameters which are considered by the use of Taguchi Methods for L27 OA and the average GRC has been tabulated and it has been represented in the GRC Graph. Enhanced equivalent multiple response variable means the GRC is considered to be high. We have selected the biggest typical GRGs were taken and idyllic permutation of the moulding parameter levels are attained through A2 (Melt temperature of 235°C), B3 (Mold temperature of 60°C), C1 (Injection pressure of 45 MPa), D1 (Holding pressure of 20 MPa), E3 (30 sec of Cooling time), F2 (Back pressure of 8 MPa), G1 (3 sec of Holding time) and H3 (Ambient temperature of 35°C). In comparison in Table 4 we have seen GRC on factor G is the largest and next comes the other ranges in the order F, A, B, H, D, E and C. This study proves that the loading time plays a major role tailed by back pressure, melt temperature, mold temperature, ambient temperature, holding pressure, cooling time and injection pressure.

Analysis Of Variance (ANOVA)

ANOVA on GRGs is carried out to find out the major contributors on the output to the different inputs which will enable us to find out the best input variable which plays a major role in influencing the output and it has been tabulated in Table 3. In this, the GRGs are restrained by the sum of squared deviations from the total mean of GRC, and are categorised into 2 phases: the summation of squared deviations on each parameter considered and the summation of squared error. Fisher's F-test is a tool to find out the moulding parameters which has major effect on the GRC. The outcomes of moulding parameters are back pressure (impact: 30.23%), holding time (27.39%) and melt temperature (15.54%) are considered to be playing major roles on weld-line width and sink-mark depth.





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Validation Experiment

Since the ideal moulding parameter is found, now the subsequent step is to identify optimum parameter levels which are used to envisage and authenticate response variables using the ideal process parameter by permutation.

The estimated GRC $\hat{\gamma}$ using ideal process parameter permutation can be derived from

$$\hat{\gamma} = \gamma_m + \sum_{i=1}^q (\bar{\gamma}_i - \gamma_m) \quad \text{-----Eq (5)}$$

Where γ_m = total mean of the GRC, $\bar{\gamma}_i$ = average GRC of the optimum level of the i^{th} molding parameter and q is the number of molding parameters which seriously marks the multiple response variables. The table 6 provides the outcomes of confirmation tests. The weld-line width is minimized from 1.0830 to 0.4720 (56.4 % improvement) and the sink-mark depth is reduced from 0.1452 to 0.0451 (68.9% improvement). It is seen from these experiments that predicted and experimental GRGs have close affiliation. This proves the helpfulness of TM based GRA to multiple response optimizations which has reduced to a reduction in weld-line and sink-mark defects.

RESULT AND DISCUSSION

Results of existing sigma level and improved sigma level has been evaluated using tables and graphs. Comparison between existing process parameters and improved process parameters has also been discussed below. The DMAIC principle of six sigma was applied to improve the quality of Polypropylene material trim parts produced by IMM01. Production equipment employed in this study is a precision injection machine, model: FERROMATIK, over all dimensions of the 856×1500×2480 mm manufactured by the FERROMATIK.

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Table 1 - Production Data

Sigma Level	Sigma (with 1.5 σ shift)	DPMO	% defective	% Yield	Short term C_{pk}	Long term C_{pk}
1	-0.5	691.462	69%	31%	0.33	-0.17
2	0.5	308.538	31%	69%	0.67	0.17
3	1.5	66.807	6.7%	93.3%	1.00	0.5
4	2.5	6.210	0.62%	99.38%	1.33	0.83
5	3.5	233	0.023%	99.977%	1.67	1.17
6	4.5	3.4	0.00034%	99.99966%	2.00	1.5
7	5.5	0.019	0.0000019%	99.9999981%	2.33	1.83

Table 2 - Injection Process

Supplier	Inputs	Process	Output	Customer
Customer Input Order Production Planning Internal order Raw Material Inventory Preheating Area Production Engineering Production Moulding	Internal Production Order Customer Parts Number Mould Specification Raw Material Mould Job Sheet	Mould Close Injection Process Hold Time Cooling Time Refill Stock Time Mould Open Part Ejection	Parts with runner Runner cutoff Moulded part Cycle info Total Production	Mould Inventory Assembly shop Warehouse PDI Inspection Part Inventory Packing Despatch to customer





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Table 3 - DPPM Data

Month	Total Production	Total Defect	DPU	Percentage of Defect	DPPM
June-21	112359	1685	0.015	1.5	1500
July-21	111559	2063	0.0185	1.85	1850
Aug-21	110659	2102	0.019	1.09	1900
Sep-21	113126	1866	0.0165	1.65	1650
Oct-21	112145	1906	0.017	1.7	1700
Nov-21	111958	2015	0.018	1.8	1800
Total	671086	11637	0.01733	1.733	1733.3

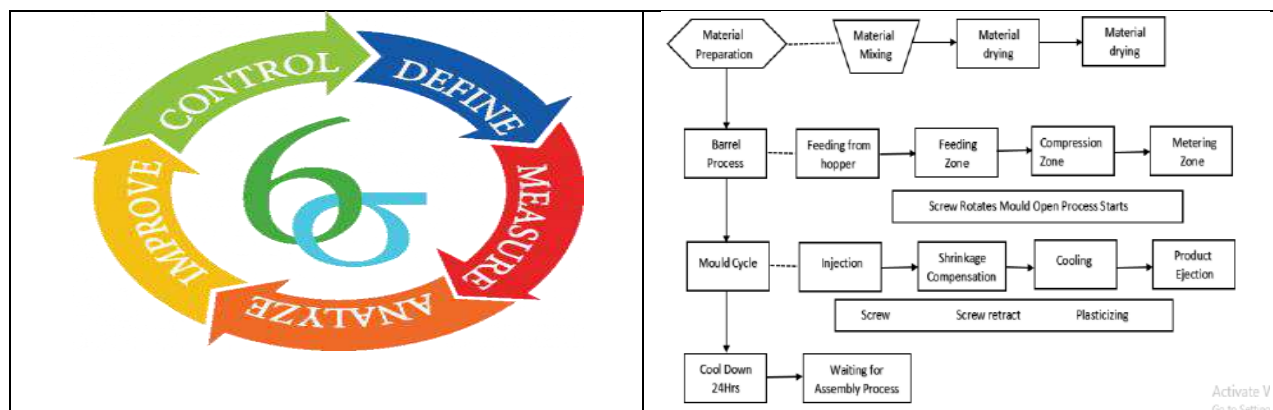


Figure 1- Six Sigma

Figure 2-Moulding Process

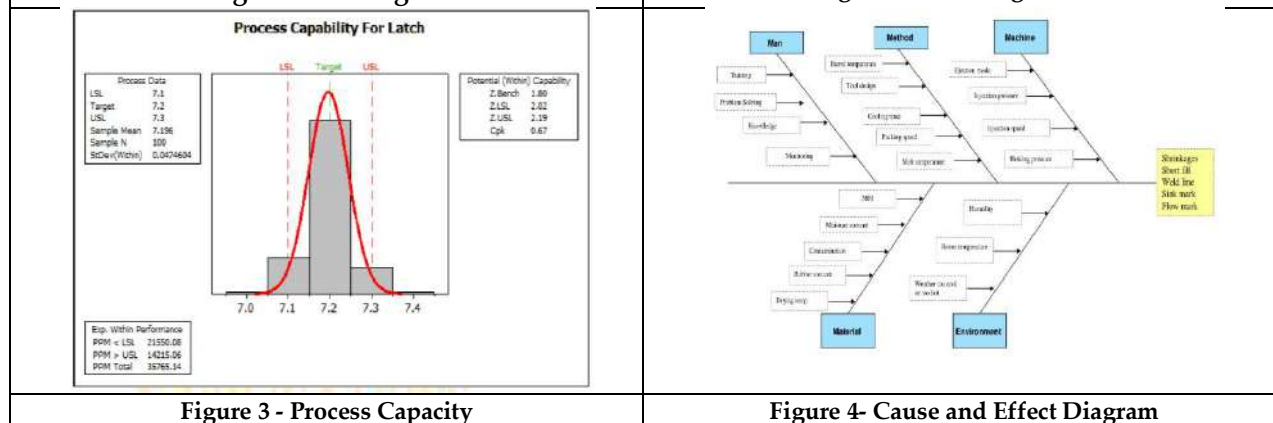


Figure 3 - Process Capacity

Figure 4- Cause and Effect Diagram





A Review on the Tribological Effect of PRA When using Engine Lubricant Doped with the Nano-Particles

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ABSTRACT

Lubricants are blended with different additives to improve different properties of the lubricants. Nanomaterials are modern additives which are getting attention in present times due to their excellent properties with regard to tribological aspects. In this paper an attempt is made to study the effect of different nano additive-based lubricant and their effect on the coefficient of friction and other properties. There is extensive work available and literature for the same is reviewed while preparing this paper. Nano materials are now not new but still there is wide scope of development and full potential of the nano materials is not yet explored. Preparation of the nano additive-based lubricant is also one of the challenging tasks because dispersion of the nano material with base lubricant should be proper and then only it will give the desired performance. It is found that there is a considerable improvement in the coefficient of friction when nano materials were used as the additive in the lubricants.

Keywords: Tribology, Lubrication, Nano additives, tribological property, coefficient of friction.

INTRODUCTION

Tribology is the term collectively used for the friction and wear as well as the lubrication. Tribology is almost applied to every modern mechanical system as friction exists there. Friction can be either useful or harmful based on the application where it is present. Friction between the tire and the road surface within the limits can be useful to generate the required traction force. Similarly in the braking operation friction is one of the useful phenomena.



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Friction between piston and cylinder liner will again create an adverse effect and here friction is not desirable as it will lead to loss of the available power. For reducing friction lubrication is used. Lubrication oil will make a layer of oil between the two surfaces which are rubbing and will reduce the friction between them and also will help in dissipation of the heat generated between the surfaces due to the rubbing action. To enhance the property of the lubricants, different additives are added to them. Some of the major additives are antioxidants, corrosion inhibitors, and antifoaming agents, pour point depressor, viscosity modifier and tribologically active additives. To our interest, tribologically active additive will improve the anti-friction and anti-wear property of the lubricant. Nanotechnology is one of the promising technologies in this century. There had been a revolution in the field of the material science with the introduction of the nanotechnology. Nano-technology has found wide applicability in different fields and has proven its potential in the same. One of the application areas for the nanotechnology which is explored is in the lubrication and tribology. Approximately 40 – 60% of power loss in the modern engines is due to the friction between piston rings and liner assembly (1). Nano materials are investigated as additive for the lubricants and are experimented for tribological performance of piston ring assembly. Numbers of papers have reported that adding nanoparticles to the lubricant will increase the wear resistance property and improve the tribological behavior of the system (2) – (10). Inorganic nanoparticles have acquired attention nowadays because stabilization problem has been solved by the use of the dispersing agent or surface modification preparation technique (8). Use of nano lubricant for controlling friction will not only improve tribological performance but also will increase the service life of the lubrication oil (11). Many experiments have been conducted using different nano particles. Selection of the nano particle is one of the important steps in preparing the nano lubricants. It has been observed that metals, metal oxides, rare earth compound, metal borates and metal sulphide exhibit better tribological properties.

Metal oxides have Tribo-sintering anti-wear mechanism in which nano particles will be tribo-sintered on the wear surface. This will create load bearing film and reduce the metal-to-metal contact (12). Many different nano materials have been studied for their tribological effect. Mostly used nanoparticles are molybdenum disulfide, graphene oxide, carbon nanotubes, boron nitride, silicon dioxide, copper oxide, titanium dioxide and graphene (13). In addition to these, combination of nanoparticles has also been studied which are commonly known as (Hybrid nanoparticles). In these studies, nano-additives with different concentrations and under different operating conditions have been experimented. It was experimented to find the correct concentration and operating conditions where this nano-lubricant can give the optimum results. It is evidently available in the literatures that lubrication regime varies from mixed lubrication to boundary lubrication depending on the film thickness ratio. In piston cylinder arrangement, at the top and bottom dead center of the piston, boundary or mixed lubrication regime occurs and at the mid of the stroke hydrodynamic lubrication occurs (11). In piston ring assembly, boundary friction and viscous friction due to shearing occurs at the asperity contact locations which are top and bottom dead center. When the oil film thickness becomes thin enough boundary friction comes into play and during this regime load is carried by the surface peak and not the lubrication film. Due to these reason nano-lubricant additives are most effective during the boundary lubrication regime and it separates the sliding surfaces by formation of the tribo-film at the asperity contact locations (14).

Preparation of Nano-Additive Lubricants

In research done by (11) oleic acid was used as a surface modifier which ensures proper dispersion of the Al_2O_3 and TiO_2 in the engine oil. Magnetic Stirrer was used for 4 hours for proper blending of the nano particles in the engine oil. UV visible spectroscopy and dynamic light scattering was method was used to elucidate the colloidal stability of the nano particles. UV absorption peak wavelength was compared for nano particle added lubricant and without nano particle and it was observed that it was higher for the lubricant with nano particle. The higher absorption peak suggests that better distribution of the nano particles in the lubricants. TiO_2 particles have better dispersion with time as compared to that of Al_2O_3 . Dispersion and stability of the nano particles in the base oil is one of the important factors which are to be considered while studying the nano additives for lubrication oil. Frictional surfaces may be damaged if proper dispersion of the nanoparticles is not done in the base fluid. Improper dispersion may cause agglomeration and precipitation of the nanoparticles (12). In research done by (12) oleic acid was used as a surface modifier and SAE20W40 was used as base oil. Cu was added to lubricant by ultrasonic probe for 45 minutes in



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concentration of 0.2 wt%, 0.5 wt%, 0.75 wt% and 1wt%. Results showed that surface modification layer was effective enough to provide good oil-dispersion and prevent agglomeration of the Cu particles in the oil. Carbon nanotubes-based lubricants were experimented by (15). Carbon nanotubes were synthesized by chemical vapor deposition method. CNT were functionalized using hydroxyl functional group using the chemical treatment process. Functionalized CNT were added to the lubricant using the ultrasonic vibrating probe. For better dispersion of the carbon nano tubes, ultrasonic vibration of more 60 minutes is needed. CuO nano particles were experimented by (16) in which CuO nano particles were added to the base oil in the concentration of 0.1% wt. Nano particles were added with the surfactant and manual paste was formed. Then the electromagnetic stirrer was used to make the proper mixing of the nano particles with the base oil and surfactant. In the study done by (17) Copper (<50 nm) and titanium dioxide (<25 nm) nano particles were used in proportion of 0.05, 0.1, and 0.2% into the base lubricant to prepare the required sample. The samples were subjected to ultrasonic vibration for 8 hours.

Additional mixing for 20 hours was done before testing the sample in the actual engine of the bike. Experiment was conducted by (18) using the SiO₂ nano particles with the average particle size of 50 to 60 nm and proportion was 0.2%, 0.4%, 0.6%, 1% by weight in the base oil. Mixing was done by continuous stirring by the magnetic stirrer at 2000 rpm and 60°C for 2 hours. After the mixing nanofluid was subjected to ultrasonic sonication for 60 minutes. In the experiment conducted by (19) graphene oxide (TEGO) Grade 1 was used as a nano additive for the lubricant and tested for the ring/cylinder liner of the internal combustion engine. One attempt was made by (20) to prepare the tungsten disulphide motor oil and tribological properties were tested. Base oil was made by concoction of different mineral oils and synthetic oils. Mixture of ultrafine tungsten disulphide grains and dressing agents was put into the absolute ethyl alcohol and heated in the inert environment. Then mixture was purified and ultrafine tungsten disulphide grains with excellent dispersibility was obtained by surface chemical embellishment. In the next step chemical embellished ultrafine tungsten disulphide grains were stirred to adsorption embellish the surfaces. Finally, the functional additives like anti-wear, antifriction, oiliness enhancer, rust resisting additives, pour inhibitor and kill foam were added, stirred and allowed to cool down. Finally, the tungsten disulphide motor oil was obtained. In a study conducted by (21), hybrid oil with nano particles of copper oxide (CuO) and Titanium di-oxide (TiO₂) were tested. To prepare the hybrid oil, paraffin oil is prepared with sesame oil in proportion of 50/50 by weight fractions.

Magnetic stirrer at 500 rpm was used for mixing of the two oils and was stirred for 5 to 6 hours at room temperature. Ethylene-vinyl acetate was added in proportion of 2 to 5 % by weight in the oil to improve the viscosity. After adding EVA, EVA particles and hybrid paraffin oil was heated and stirred in magnetic stirrer at 500 rpm at 70°C for 4 to 5 hours. Nano lubricant sample was mixed using the magnetic stirrer for 5 hour and then using water bath sonication nano lubricants were dissolved into the base oil. Butylated hydroxyl toluene was used as oxidation inhibitor. BHT particles were heated with the hybrid paraffin oil and stirred with the magnetic stirrer at 400 rpm for 6 to 7 hours and keeping temperature at 80°C. In a study done by (22), ZnO-MWCNT was used to test the rheological behaviour. Hybrid nano lubricant samples were prepared with the solid fractions of 0.05%, 0.15, 0.25%, 0.5%, 0.75% and 1%. Nano particles were dispersed in the base oil. Then to make the stable and homogenous suspension ultrasonic waves of 20 KHz for 6 hours were used. Viscosity of the sample was measured using the Brookfield viscometer. In a study conducted by (23), Zinc oxide was used as friction modifier in the neat castor oil. Proportion of nano lubricant by weight was 0.1, 0.5, 1.0, and 2.0 on the percent basis. Sonication for 45 minutes was done using probe sonicator to make the suspension stable and homogenous. In an experiment done by (24), carbon nanotubes and graphite were used as the nano additives. In a 500ml of base oil 0.1% by weight CNT was added. After adding CNT, mixture was subjected to ultrasonication bath and then homogenizer to get the equal dispersion of the CNT in the lubricant.

Experimentation and Results

Al₂O₃ and TiO₂ were used as nano additive for the lubrication oil in the experiment done by (11). Bench tribometer was used in such an arrangement that it mimics the reciprocating piston ring/liner interface. Some important parameters were observed during the tribological testing and that were friction coefficient, power loss, and wear rate of the ring. The load in the experiment varied from the 30 to 250 N which was equivalent to the contact pressure



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ranging from 0.65 to 5.43 MPa and 50 to 800 rpm speed was used. Temperature of the lubricating oil during the test was kept at 100°C. It was observed that there was considerable reduction in all the tribological parameters. In an experiment conducted by (12), magnum tribo-tester was used. Pin on disk configuration with sliding contact was used for friction and wear testing. Loading condition was 30 N, 50 N, and 65 N. The disk had 1000 rpm and temperature was ambient when testing was carried out. Testing was carried out for 10 minutes. Coefficient of friction and wear rate was recorded during the experiment. It was observed in the experiment that as compared to pure oil, lubricant with nano additive showed the reduced wear and coefficient of friction. In an experiment done by (15), carbon nanotubes were used as the additive in the military utility vehicle engine lubricant. Test was conducted on the engine in no load condition. It was tested for the temperature reduction in the engine temperature and fuel saving. It was observed that there was drop of 10°C temperature in no load condition and up to 10% of fuel saving was observed. In an experiment done by (16), reciprocating friction monitor with reciprocating pin with fixed block was used. The loading condition and speed was as per the working condition of the IC engine. Experiment was carried out at different lubricant temperature of 30°C, 60°C, 90°C. The block specimen and pin were made from mild steel. The pin was reciprocated with the speed of 1mm/second. From the results it was inferred that the lubricant with CuO particles has lower friction coefficient as compared to that of lubricant without nano additive.

In same experiment analysis was done using four ball tester where 390 N of force was used with rotational speed of 1200 rpm for one hour. The results of this experiment revealed that there was reduced wear scar diameter when the lubricant with CuO nano particles were used. In an experiment done by (17), lubricant dispersed with CuO and TiO₂ was used to study the effect on the thermal efficiency, frictional power and fuel consumption. The test was carried on the motor bike mounted on the roller test bench. From tribological aspects it is observed that there was reduction in the frictional power loss and it also reduced the fuel consumption. In an experiment done by (18), Pin on Disc wear and friction test rig was used for the experiment. Coefficient of friction was tested for fully flooded condition as well as starved condition with constant load of 40N. Compositions of the nanoparticles were changed and friction coefficient was tested and optimum composition was found. In fully flooded condition, 0.6% of the nano particle by weight showed the reduction in the friction coefficient. Further if the concentration was increased then there was increase in the friction coefficient. In starved condition also the results were identical to that of fully flooded condition. In an experiment done by (19), custom made tribo tester was used for conducting the wear test. Load was set to constant of 60N and temperature was kept at 100°C. Tribo test were conducted for 22 minutes. It was observed that there was reduction in the friction coefficient when graphene nano additives-based lubricant was used. In the experiment conducted by (20), four ball tester with ball diameter of 12.7 mm was used to conduct the wear test. Temperature was kept at 40 and 100 degrees Celsius. 392 N Load was kept at 450 rpm. When the tungsten disulphide motor oil was used, there was considerable reduction in the friction coefficient and this proved that tungsten disulphide motor oil has excellent lubricating properties.

In an experiment conducted by (21), thermal, rheological and tribological properties were tested for the hybrid lubricant made from combination of sesame and paraffin oil and then the hybrid oil was doped with nano particles TiO₂ and CuO. We are here concerned for the tribological properties and that were tested using the standard four ball tester with the ball diameter of 12.7 mm and hardness of HRC 61 – 64. It was observed that friction coefficient and wear scar diameter both reduced when hybrid paraffin oil was used. Further when this hybrid paraffin oil was doped with different concentration of the TiO₂ and CuO there was reduction in the friction coefficient and wear scar diameter. If the comparison is made again with respect to both nano particles, lubricant with TiO₂ was more effective as compared to that of CuO. In experiment conducted by (23), four ball test rig was used to determine the anti-wear property. Experiment was conducted at 392 N load and 1200 rpm. Temperature for test was kept at 75 degrees Celsius and test was conducted for 3600 seconds. Balls used in the testing were having 12.7 mm diameter with roughness value of 0.143 µm and hardness was approximately 60 HRC. Three repeated experiments were conducted and the average value of the reading was noted. Optical microscope was used to observe and measure the scars on the balls. Extreme pressure properties were also tested. Roughnesses of the surfaces were observed using the three-dimensional profilometer. Root mean square and average roughness were determined along the scar diameter. Ball surfaces were analyzed using SEM and energy dispersive system to know about the plausible wear mechanism.



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From results it was identified that friction coefficient was less for neat castor oil as compared to commercial mineral oil. Further with addition of zinc oxide, there was reduction in the friction coefficient and it was low as compared to both neat castor oil and commercial mineral oil. In an experiment conducted by (24), four ball tester was used to test the anti-wear properties of the lubricant with CNT as nano additive. Castor oil was used as base oil and different composition of additive in lubricant oil was used in the test. Constant speed of 1200 rpm and temperature was 75 deg. C was kept with constant load of 39.2 kg during the test. Test was conducted for 3600 seconds. It was observed that there was reduction in the sliding friction and friction coefficient when CNT was used.

CONCLUSION

Following conclusions can be derived from the review of all the experiments and tests; In preparing the lubricants with the nano additives, it must be taken care that dispersion of the nano particles is done properly in the base oil. If the dispersion is not done properly, agglomeration of the particles may take place and the lubricant may not give the desired results. For proper dispersion and to prevent agglomeration oleic acid is used as the surface modifier and for proper mixing ultrasonic sonication is used. Almost in all the research this is found same. Composition of the additive also matters in the lubricant and it should be selected properly so that optimum performance is obtained. Generally, 0.5 to 0.6% by weight in the quantity of base oil is the optimum composition which gives the best result. Mostly, oxides of metal and rare earth metals are used as the nano additives. To name some common, copper oxide, zinc oxide, titanium dioxide, Silicon dioxide etc are used. Besides this Carbon nanotubes are also experimented as the nano additives for the lubricating oil. Either these additives are added individually or combination of these additives are added and tested. Base oil is generally taken as regular paraffin-based oil available and in some special cases mineral oil and synthetic oil are combined and this hybrid oil is used as the base oil. Addition of the nano particles to the base oil will improve the viscosity of the oil as well. Besides from tribological properties, rheological properties of the oil are also improved. Viscosity at higher operating temperature, oxidation stability and anti-wear properties are found to be improved with the addition of the nano particles. Almost all the nano additives have shown good anti-wear property when tested. This indicates that the concept of nano lubricant has wide scope and good potential. Particularly in the application of the IC engine these nano-added lubricant can give very good wear resistance and also it will enhance the life of the components and improve the fuel efficiency by reducing the frictional power loss between the ring/liner assemblies in the IC engine. It is noted by (25) that when carbon nano tubes are used, reduction in the friction coefficient is there under dry sliding conditions and there is no reduction in under lubricated conditions. Effective time for dry condition is limited for the CNT and friction coefficient reduces further with the increasing amount of the CNT. Adhesiveness is the dominant wear mechanism in the dry conditions when carbon nano tubes are used as the nano additives for the lubrication oil.

FUTURE SCOPE

Nanotechnology has been more focused since last decade and particularly has attracted the attention of the researchers to utilize the nano materials as the additives for the lubrication oil. Many experiments have been done in the same area and many important results have been derived out of which some important experiments and their outcomes have been reviewed in this paper and presented in the preceding section of this paper. Apart from these there are few more areas needed to be explored in the future studies which are as discussed below; All the experiments are done on the tribometer or some other friction or wear test bench which resembles the actual working condition. These results can be accepted and considered base for the further testing of these lubricants in the actual running condition. These lubricants can be tested in the actual engine subjected to endurance test for the components and then the properties of the lubricant as well as the wear and tribological properties of the engine should be evaluated. Further, more nano additives should be explored which are not widely tested. Most researches are done on the oxide-based additives and nano additives like graphene, tungsten disulphide and molybdenum are less explored. Service life of the nano lubricant should be tested by experimenting it in the actual running conditions.





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Apart from the tribological aspects, emissions and impact on the environment should be also studied if such nanoparticle added lubricant is combusted in the engine, what type of emission will it make. Cost of such lubricant should be calculated if it is intended to be used in the real applications.

NOMENCLATURE

Cu	Copper
CuO	Copper Oxide
TiO ₂	Titanium Dioxide
SiO ₂	Silicon Dioxide
Al ₂ O ₃	Aluminum Oxide
ZnO	Zinc Oxide
WS ₂	Tungsten Disulphide
PAO	Polyalphaolefin

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Table 3: Summary of Test Result

Ref. No.	Test Method	Base Oil	Nano Additive	Test Parameters		Effect on Friction Coefficient	Comments
				Load	Temperature		
(2)	Reciprocating Sliding Tribotester	API-SF (SAE 30)	CuO	100 N and 200 N	40 to 160° C	↓	18.4% reduction in friction coefficient
(5)	Four Ball Tester	Engine Oil	Cu	294 N	25, 50, 80, 110 and 140°C	↓	Reduction in wear scar diameter and Friction.
(6)	Fixed block with Roller	SAE 30	Cu	110N and 184N	100°C	↓	Cu (N ₂) showed the best results





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(8)	Magnum's Tribo-Tester	Paraffin + SN-500	SiO ₂	10N, 30N, 50N	Room Temperature	↓	Friction Coefficient was reduced.
(9)	Four Ball Tester	500 SN	CeO ₂ & TiO ₂	392N	Room Temperature	↓	0.6% by weight showed the optimal tribological properties
(10)	Pin on Disc Tribometer	Biodiesel	ZnO	30N	Room Temperature	↓	ZnO improved lubricity of Biodiesel
(11)	Bench Tribometer	Castrol Edge 5W30	Al ₂ O ₃ and TiO ₂	30 to 250 N	100°C	↓	All tribological properties were improved
(12)	Pin on Disc Tribometer	20W40	CuO	30N, 50N, 65N	Room Temperature	↓	Due to deposition of nano particles on rubbing surface, tribological behavior improved
(16)	Four Ball Tester	SAE 15W40	CuO	390N	30, 60, 90°C	↓	-
(17)	4T Hero-Honda Bike Engine	20W 40 API	Cu and TiO ₂	-	-	↓	-
(18)	Pin on Disc Test Rig	SAE 40 (15W40)	SiO ₂	40N	28°C	↓	0.6% by weight is optimum composition of nano additive.
(19)	Custom Made Tribo-Tester	5W40 Full Synthetic Oil	Graphene	60N	100 °C	↓	Due to Layering of nano additives on rubbing surface, Frictional behavior was improved.
(20)	Four Ball Tester	Synthetic and Mineral Oil	Tungsten Disulphide	392N	40 and 100°C	↓	Tungsten disulphide motor oil has excellent lubricating Properties
(21)	Four Ball Tester	Paraffin-Sesame (50:50)	TiO ₂ and CuO	40 Kg	75°C	↓	Hybrid Paraffin oil with TiO ₂ shows best tribological property
(23)	Four Ball Test Rig	Castor Oil	Zinc Oxide	392 N@1200rpm	75°C and Room	↓	0.1% of Zn improved the



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					Temperature		AW and EP properties but beyond this composition, wear rate increased
(24)	Four Ball Tester	SAE 15W-40	Carbon Nano Tube	39.2 kg	75°C	↓	Graphite was used in same experiment to test the EP resistance.





Impact of Patient Counselling in Management of Complications in Pregnancy

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ABSTRACT

This study aimed to assess clinical pharmacists' contributions to pregnancy-related treatment. It conducted prospective observational research across several teaching hospitals in Bhimavaram, focusing on medication adherence, comparing issues in adolescent and adult pregnancies, and determining pregnancy-related difficulties. Patient demographics were collected and analyzed. The results showed higher maternal complications in adults and more fetal-related issues in adolescents. Medication adherence improved significantly post-counseling on lifestyle factors and medication management. The study highlighted the importance of pharmacist involvement in promoting drug adherence and concluded that pharmacists significantly contribute to enhancing medication adherence in the Gynaecology department.

Keywords: Clinical Pharmacists, Pregnancy-Related Problems, Medication Adherence, Adolescent Pregnancy, Adult Pregnancy, Prevalence, Maternal Complications, Fetal-Related Complications, Counseling.





INTRODUCTION

The research aims to assess the contribution of clinical pharmacists in the treatment of pregnancy-related problems, including medication adherence, and to compare problems related to adolescent pregnancy to those related to adult pregnancy. This research is relevant in highlighting the importance of pharmacist's role in improving medication adherence and managing pregnancy-related complications. Previous studies have emphasized the importance of medication adherence in improving pregnancy outcomes, and clinical pharmacists have been shown to play a crucial role in promoting medication adherence. However, there is a lack of research focusing on the specific contribution of clinical pharmacists in managing pregnancy-related problems, especially in adolescent populations. The study's findings that fetal-related complications were more prevalent in adolescents than in adults and that medication adherence improved significantly after counseling are in line with previous research. Additionally, the study's recommendation for pharmacists to provide support and education to pregnant patients is also consistent with previous studies emphasizing the need for patient education and counseling. Overall, this research adds to the existing literature by highlighting the specific contribution of clinical pharmacists in managing pregnancy-related problems, particularly in adolescent populations, and emphasizing the importance of medication adherence in improving pregnancy outcomes.

MATERIALS AND METHODS

The study was carried out at multiple healthcare facilities in Bhimavaram, Andhra Pradesh, India, including mother and child care hospitals and a tertiary hospital. These facilities were selected as they serve a diverse population, making them suitable for studying the prevalence of pregnancy complications. By including multiple sites, the study was able to collect a more representative sample and provide a broader understanding of the adult and adolescent pregnancy complications faced by the local population.

Study Design

The study design used in this study is a prospective observational cross-sectional design. This design involves collecting data at a single point in time to assess relationships between variables, in this case, the contribution of clinical pharmacists to managing pregnancy-related problems and comparing complications related to adolescent pregnancy to those related to adult pregnancy.

Study Type

The study type is quantitative, as the study involves the collection and analysis of numerical data. The study used statistical analysis to evaluate the differences between adolescent and adult populations in terms of pregnancy-related problems, medication adherence, and complications.

Study Duration

The study was conducted over a period of six months.

Study Criteria

Inclusion Criteria

- Age group \geq 15 years
- Pregnant Women with any complication
- Women of all trimesters
- Subjects who were willing to participate

Exclusion Criteria

- Non –pregnant women



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- Post menopausal women
- Subjects who were not willing to participate in the study
- Subjects having a social history of smoking, drinking alcohol were excluded
- Subjects who were having life threatening diseases or disorders were also excluded

Study Procedure

The study obtained ethical clearance from the Institutional Ethical Committee and used a self-framed data collection form for data collection, which included information on the participants socio-demographic and obstetric history. The participants were asked about their awareness and medication adherence using the MMAS-8 scale. Informed consent was obtained, and the data was validated, examined, and reported.

Statistical Methods

The study used MS Excel for data entry and GraphPad Prism9 for analysis and graphs. Frequency and percentage were used to summarize demographics and complications. Different statistical tests were used such as PAIRED T TEST and UNPAIRED T TEST to assess mean differences and statistical differences between groups. TWO-WAY ANOVA was used to analyze the effect of two independent variables on two or more dependent variables. The P VALUE of <0.05 was considered statistically significant.

RESULTS

The research study collected patient demographics from both adult and adolescent populations, and counseling was based on the MMAS-8. The age range of the majority of participants was between 21-25 years (as shown in Figure 01), and they were primarily classified as gravida G1 (as shown in Figure 02). Additionally, most participants had no relevant medical history (as shown in Figure 03), lived in rural areas (as shown in Figure 04), and were unemployed (as indicated by the educational status data in Figure 05). Anemia was observed in both adult and adolescent groups, with a more significant difference seen in the 10.5% and 8-10% groups (as shown in Figure 07). Infection was more prevalent in T3 for both groups, but it was more commonly observed in adults in T3 and adolescents in T2 (as shown in Figure 08). Abortions and fetal death were commonly seen in adults (as depicted in Figure 09,10). Amniotic fluid analysis revealed a significant difference in the occurrence of mild and moderate oligohydramnios classes, with a higher frequency in the third trimester regardless of age (as shown in Figure 11). Gestational diabetes mellitus was more prevalent in adult groups compared to adolescents (as shown in Figure 12), and hypothyroidism was more commonly observed in the adolescent group during the second trimester and in the adult group during the third trimester (as shown in Figure 13). PIH was more prevalent in the adult group, while PROM was more commonly observed in the adolescent group (as depicted in Figure 14). Breech presentation was more prevalent in adolescents during the second trimester and in the adult group during the third trimester (as shown in Figure 15). Additionally, the occurrence of floating head and fetal distress was more commonly observed in adolescent groups (as shown in Figure 16). After analyzing the data, we found that maternal complications were more prevalent in adults, whereas fetal related complications were more prevalent in adolescents. Figure 17 depicts this trend. Additionally, our analysis revealed that the age group of 27-31 had a lower prevalence of maternal complications when compared to other adult age groups, as shown in Figure 18. Prior to counseling, medication adherence is low in both adults and adolescents. However, after receiving counseling, medication adherence significantly improved (as shown in Figure 19 & 20). The counseling program incorporates guidance on physical activities, dietary habits (recommended and restricted foods), sleeping patterns, and medication management.

DISCUSSION

A prospective observational cross-sectional study was conducted among pregnant women in Bhimavaram, Andhra Pradesh, to observe the prevalence of complications in pregnancy. The study included 786 subjects, and patient information was collected from the patient case sheet. The demographic profile of the study population was



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segregated according to age, gestational age, and the complication they had. The present study highlights the prevalence rate of complications among different pregnancy age groups and their medication adherence improvement after proper counseling. The enrolled patients were aged 18 years and above, with most of them being in the age group of 21-25 years. These results were in accordance with other studies conducted by Dr. Mohini Rajoriya *et al.*, (2020)[4], Devkota *et al.*, (2017)[5], Minjares-Granillo *et al.*, (2015)[6]. In the study, the majority of the participants were primigravida (48.7%) and in the third trimester (55.8%). These results were in accordance with the study by Devkota *et al.*, (2017)[5], while Dr. Mohini Rajoriya *et al.*, (2020)[4] found that the majority were multigravida. The distribution of past medical history among participants showed that the majority did not have a known medical history, and of the participants having one, complication of hypothyroid was more common (2.29%). The study participants were from a rural community (445), with a secondary education and unemployed. The number of pregnancy-related complications was high, and being an urban resident was a contributing factor. These results were not in accordance with the study conducted by T G Delele *et al.*, (2021)[7], where participants in rural localities were more. There was a high prevalence of anemia, which increased with trimester, and was in accordance with Wemakor A *et al.*, (2019)[8]. Additionally, we compared the prevalence of anemia in adolescents and adults during pregnancy. Participants having anemia were very low in class 10.5% (Adolescent = 0%, adults = 0.5%). Participants having anemia in class 8-10% were more in adults. Participants having anemia in class 5-7% were more in adolescents. A study with 786 subjects reported that the percentage of abortion was 10.3%, neonatal death was 1%, and the majority of cases were from the adult group. This is in contrast to a study conducted by the Centers for Disease Control and Prevention (CDC), which found that fetal mortality rates were higher among teenage mothers compared to adult mothers [9]. The majority of participants in both groups showed a high prevalence of mild oligohydramnios, of which the adult group (16%) had a higher prevalence than the adolescent group (13.7%). Adolescents had almost similar percentages of having moderate (5.57%) and severe oligohydramnios (5.1%). Adults showed a higher percentage of having moderate oligohydramnios (5.7%) than severe oligohydramnios (3.05%). This is in contrast to a study published in the Journal of Obstetrics and Gynaecology in 2018, the incidence of oligohydramnios was found to be higher in teenage pregnancies compared to adult pregnancies [10]. Polyhydramnios was more prevalent adults (1.97%) than in adolescents (1.71%) in the third trimester. This is in accordance to the study published in the Journal of Maternal-Fetal and Neonatal Medicine in 2019 [11].

The study revealed that the majority of participants who experienced a complication of gestational diabetes mellitus (GDM) were from the adult group, with a prevalence of 8.99%, while adolescents only accounted for 4.29%. This is consistent with a study published in the Journal of Obstetrics and Gynaecology Research in 2015, which found that the prevalence of GDM was significantly higher in adult pregnancies compared to teenage pregnancies [12]. Furthermore, a systematic review and meta-analysis published in the Journal of Diabetes Investigation in 2019 also supported this finding, reporting a higher prevalence of GDM in adult pregnancies compared to teenage pregnancies [13]. In our study, it was observed that the majority of participants who experienced a complication of hypothyroidism were from the adolescent group, accounting for 2.14%, while only 1.79% of adults were affected. There may be various underlying factors contributing to this observation

Furthermore, our study found adult groups (5.21%) had more percentages of occurrences for PIH complications, with adolescents having a rate of 4.29%. These results were in agreement with the study conducted by AYELE MAMO ABEBE *et al.*, (2020)[14]. On the other hand, the occurrence of eclampsia was rare, and our study showed a percentage occurrence of 0.17% in the adult group. Our study found that the occurrence of PROM was higher in the adolescent group (16.3%) compared to the adult group (12.4%). This is consistent with a study published in the Journal of Obstetrics and Gynaecology Research in 2017, which reported a higher incidence of PPROM in teenage pregnancies compared to adult pregnancies [15]. Additionally, our study concluded that the occurrence of floating head and fetal distress were more common in the adolescent group compared to the adult group. This is in accordance with a study published in the Journal of Obstetrics and Gynaecology Research in 2018, which found that the prevalence of fetal distress was higher in teenage pregnancies compared to adult pregnancies [16]. However, for floating head, a study published in the Journal of Ultrasound in Medicine in 2018 found that the prevalence of the floating head sign, which is a sign of fetal head engagement, was lower in teenage pregnancies compared to adult



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pregnancies [17]. Breech position was found to be more prevalent in adults during the third trimester and in both adults and adolescents during the second trimester. This contrasts with a study published in the Journal of Obstetrics and Gynaecology Research in 2019, which reported a higher incidence of breech presentation in teenage pregnancies compared to adult pregnancies [18]. In our study, we found significant differences in the MMAS-8 Scale scores before counseling with respect to age. However, there was an increase in scores assessed after counseling, and the results were found to be statistically different with respect to age. These findings were consistent with the study conducted by Devkota *et al.*, (2017)[5]. It is important to note that including counseling as a part of antenatal care may help improve medication adherence in pregnant women.

CONCLUSION

In our study, we found that fetal complications such as breech, floating head, fetal distress, and PROM were more common in adolescents than in adults. Conversely, adults experienced more maternal complications such as anemia, infection, abortion, GDM, PIH, hypothyroidism, oligohydramnios, polyhydramnios, neonatal death, and eclampsia. Our research also revealed that the age group of 27-31 was the most suitable for pregnancy, as maternal complications were less frequent in this age group compared to other age groups. Moreover, we observed that medication adherence increased in both adolescent and adult participants after counseling by pharmacists. The role of Clinical Pharmacists in discussing the benefits of medication adherence, providing support, and explaining the advantages and disadvantages of treatment was found to be critical. Based on our findings, we conclude that pharmacists have a significant impact on improving medication adherence in the Gynecology Department.

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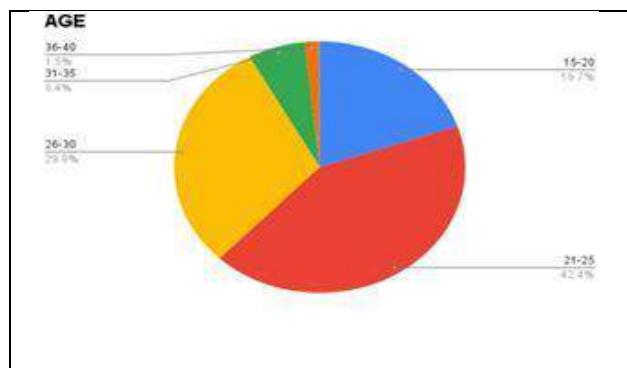


Figure 1 Age wise percentage distribution in study population

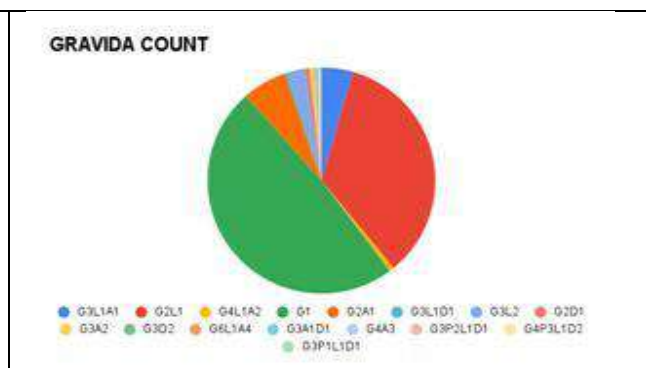


Figure 2 Gravida wise percentage distributions in population

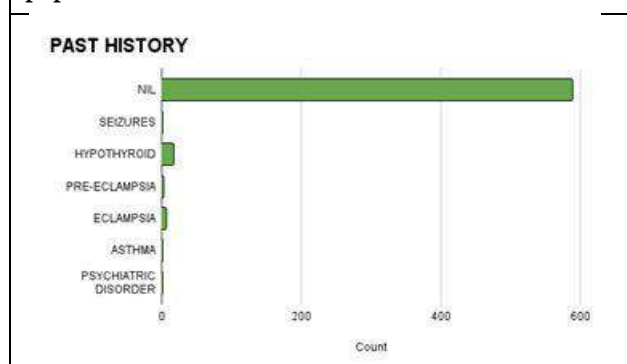


Figure 3 Past histories in study population

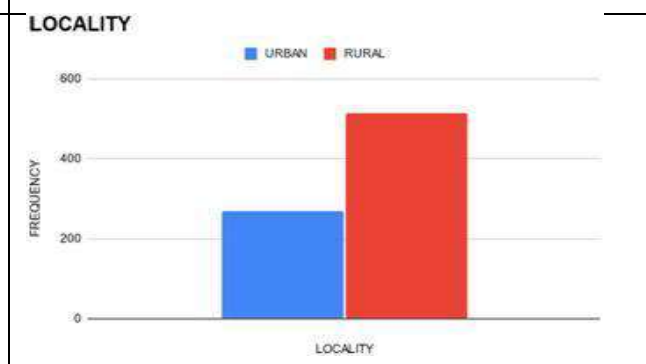


Figure 4 Locality distributions in study population





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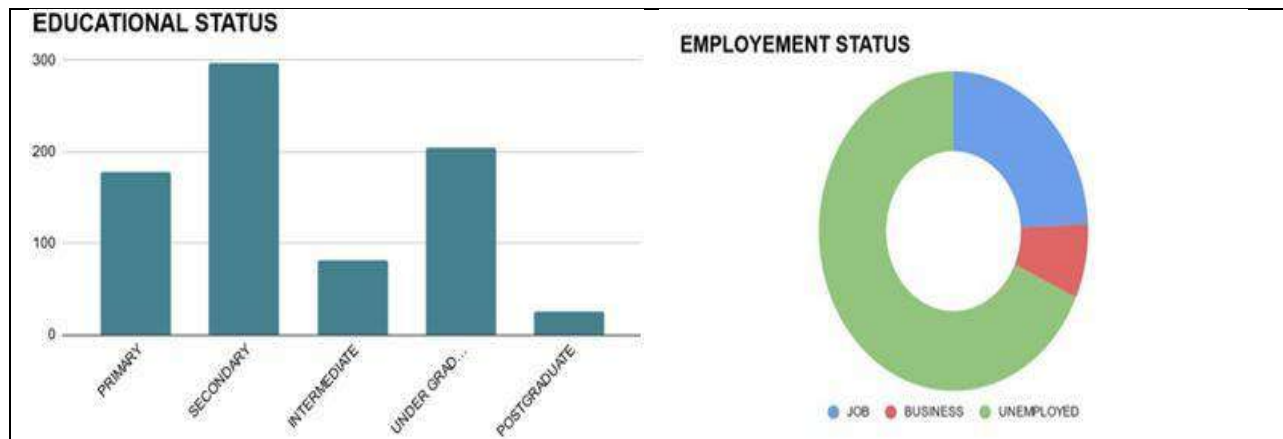


Figure 05 Educational statuses in study population

Figure 06 Employment status in study population

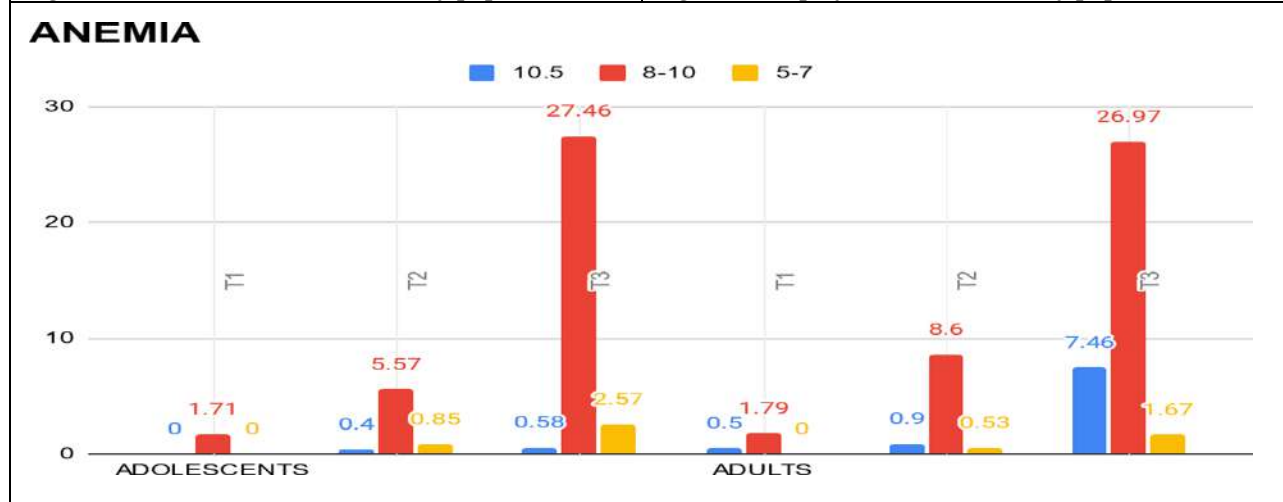


Figure 07 Age Wise Distribution of Anemia In Different Trimesters

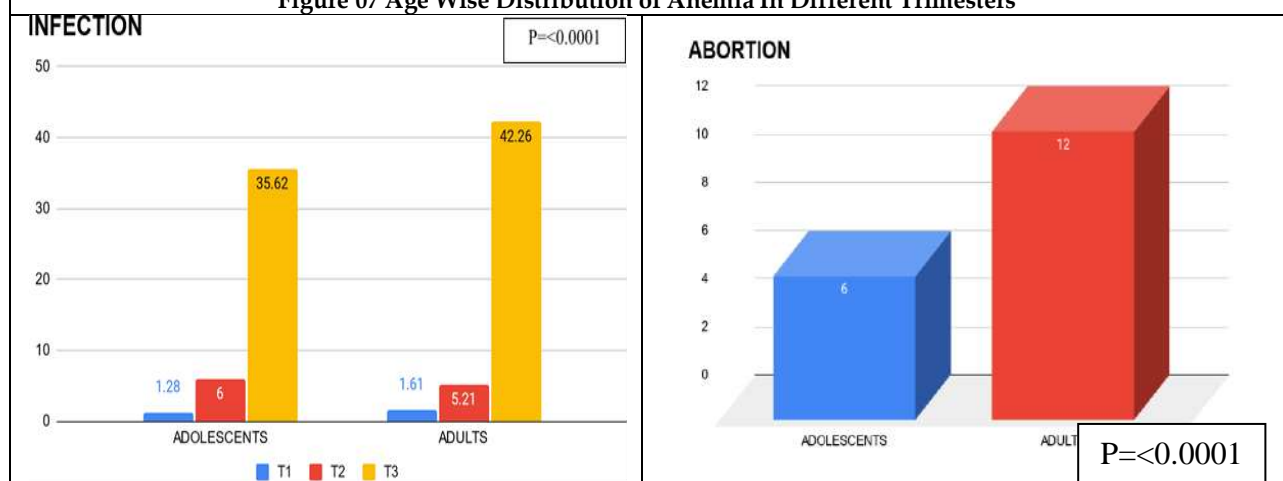


Figure 08 Age Wise Distribution of Infection in Different Trimesters

Figure 09 Age Wise Distribution of Abortion



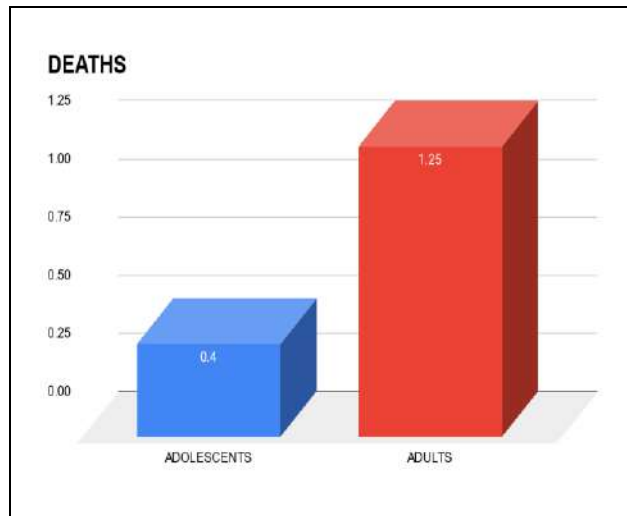
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Figure 10 Age Wise Distribution of Neonatal Death

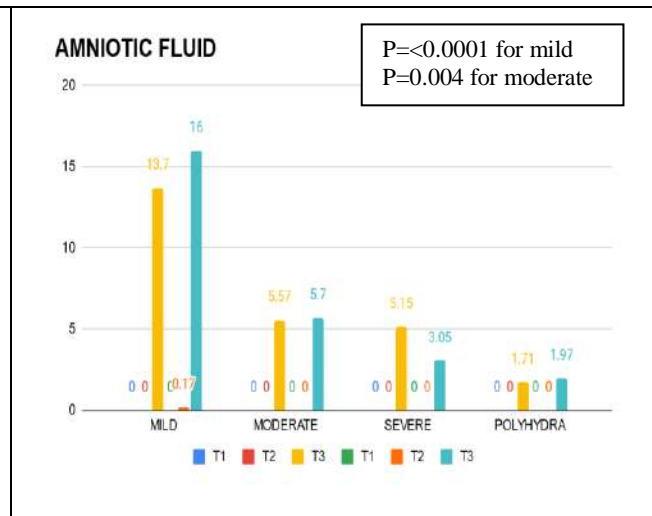


Figure 11 Age Wise Distribution of Oligohydramnios in Different Trimesters

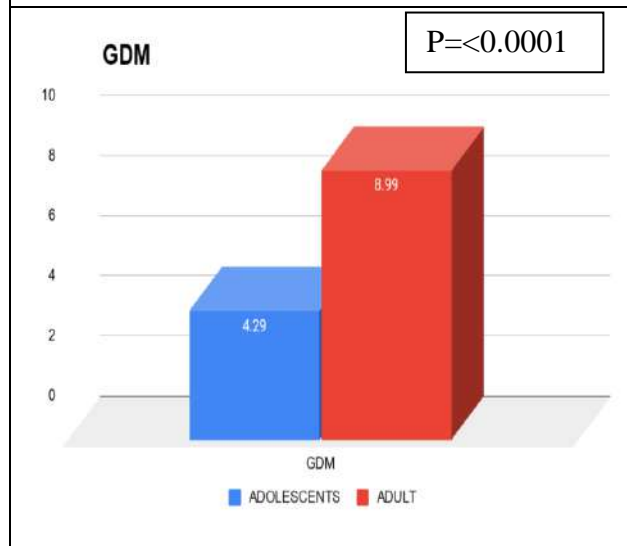


Figure12 Age Wise Distribution of Gestational Diabetes Mellitus

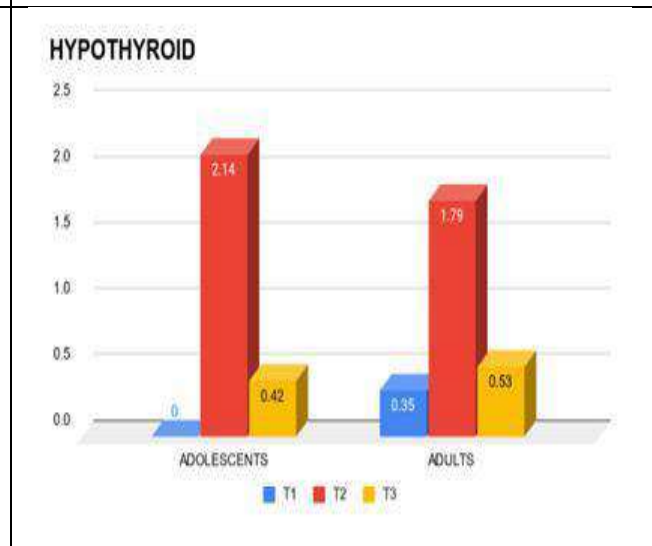


Figure13 Age Wise Distribution of Hypothyroid



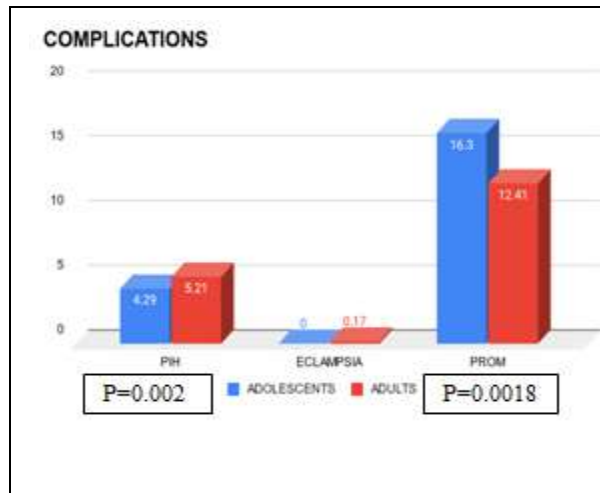


Figure14 Age Wise Distribution of PIH, Eclampsia, PROM

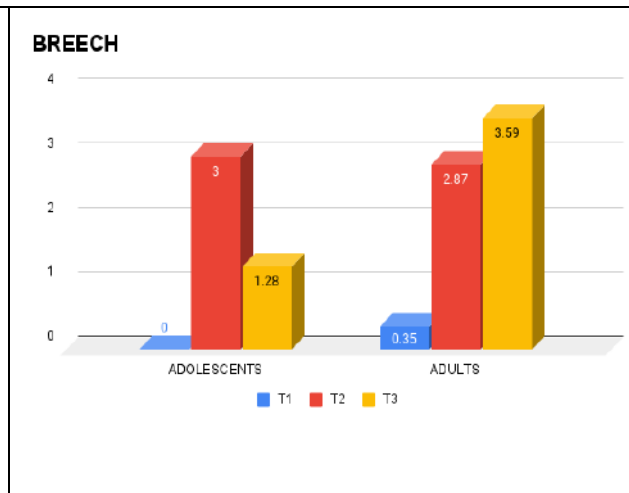


Figure 15 Age Wise Distribution of Breech

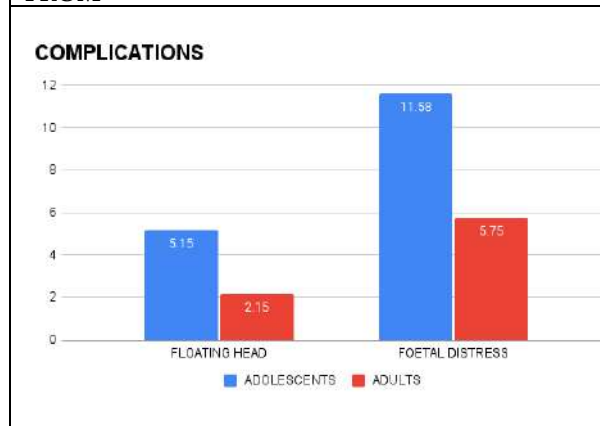


Figure16 Age Wise Distribution of Floating Head & Fetal Distress

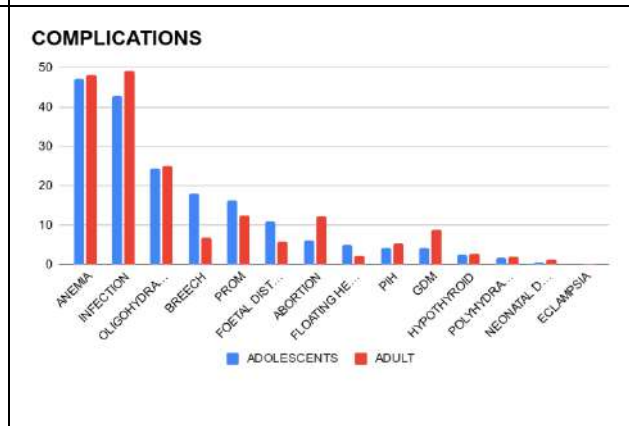


Figure 17 Percentage Distributions of Complications among Adolescents to Adults

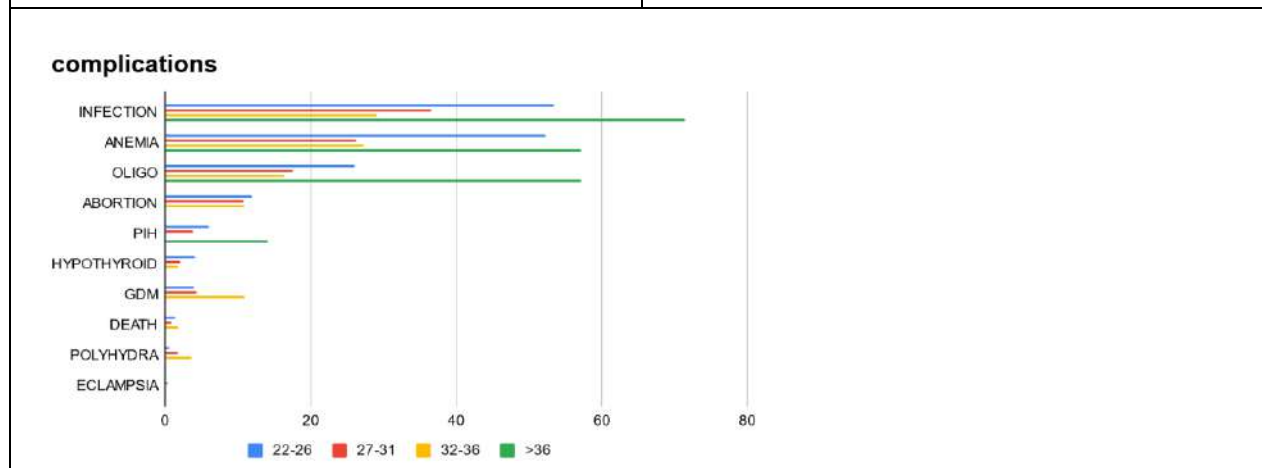
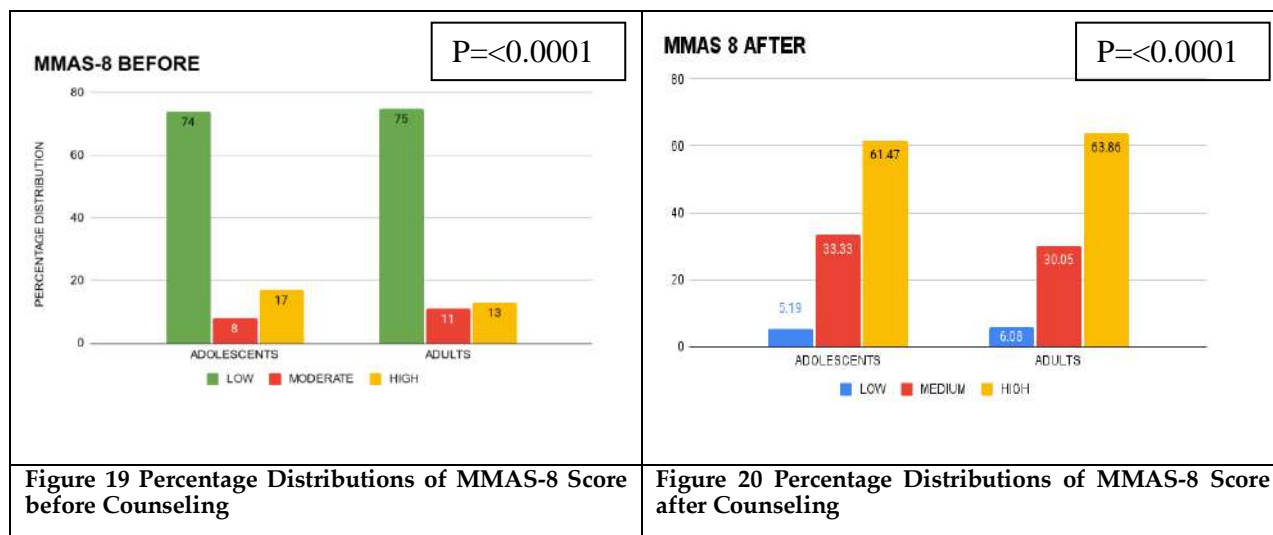


Figure 18 Percentage Distributions of Complications among Adult Age Groups





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An Examination on the Reliability and Rewards of Chennai Yoga Aspirants

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ABSTRACT

This study is limited on yoga's efficacy and advantages. Practitioners in this study concentrated on the respondent's controlled age, gender, and monthly yoga costs. Above these factors and relationships between the controlled variables, such as VA1 Daily yoga practice beneficial to health, VA2 improve flexibility, VA3 muscle building, VA4 protect your Spine, VA5 human bones, VA6 blood circulation, VA7 maintenance of nerves system, VA8 mind relax system, VA9 cardio and circulatory health, VA10 protection from injury, VA11 balance and relaxes you system, VA12 weight loss, and VA13 medication for the diabetes. All of these elements have a substantial correlation with the study's variables.

Keywords: Above these factors and relationships between the controlled variables

INTRODUCTION

Yoga focuses on the advantages of both physical and mental health; it is a form of bodily meditation. In large cities like Chennai, people lead mechanical and stressed-out lives; yoga is the finest remedy for leading a happy, healthy, and tranquil existence and avoiding such mechanical or stressed-out lives. Yoga is primarily a spiritual discipline based on incredibly delicate science that focuses on establishing harmony between the mind and body. It is a way to calm the human mind. Healthy living is both an art and a science. Sanskrit is the source of the word "yoga." Yoga practice results in the fusion of personal awareness with global consciousness. Modern scientists believe that



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everything in the cosmos is really an expression of the same quantum firmament. One who has gained a degree of freedom and experiences this oneness of being is referred to as a "yogi" and is believed to be practicing yoga. Yoga also refers to an internal science that includes a range of techniques for helping people unite their body and mind in order to experience self-realization. Yoga practice's (sadhana) main goal is to liberate oneself from all forms of pain in order to achieve overall wellness, happiness, and harmony in all spheres of life.

Statement of the Problem

Description of the issue Health in humans indicates that the physical and mental capacities of the body are sufficient. Every human being has to satisfy this criteria in order to live their daily lives. A child's prenatal time indicates their prenatal health. To ensure that every organ of the kid develops normally and functions without malformations, impairments, or illnesses, intensive protection and care are required. However, society frequently ignores children's health, causing them to grow up unwell and hinder their ability to learn. As a result, healthy kids grow up to be healthy adults. The youngster in this scenario, who does not do yoga, is afflicted with numerous illnesses, disabled in some manner, and his illness ruins his maturity. He is unable to enlist in any active military service, achieve career achievement, or lead a fulfilling life. Health cannot be attained by taking one or two medications daily or by adhering to a few rules. To acquire health, one must first grasp what it is and what factors influence it, and then apply what they have learned to their daily activities. The body's case in relation to nutrition, hygiene, exercise, yoga, rest, and illness prevention are crucial for the maintenance of good health. Health may be divided into two categories: physical and mental.

Goals for the Study

To do research in Chennai on the efficacy and advantages of yoga practitioners.

STUDY'S SCOPE, SAMPLE, AND DATA COLLECTION

The current study was limited to the usefulness of yoga, its advantages for Chennai workers, and the effectiveness of yoga practitioners. There were about 5000 yoga practitioners in Chennai. The researcher used straightforward random sampling methods. Data from the interview schedules were gathered for this study, which only relied on primary and secondary data. The second data was gathered through the internet, newspapers, and other sources. Controllable and controllable variables made up the correlation table's variables. Age, gender, and monthly costs were controllable and controllable variables. Everyday yoga practice is beneficial for your health in the following ways: VA1 Improves flexibility; VA2 Builds muscle; VA3 Protects your Spine; VA5 Human Bones; VA6 Blood Circulation; VA7 Maintains Nerves; VA8 Relaxes the Mind; VA9 Cardiovascular Health; VA10 Protects Against Injury; VA11 Balances and Relaxes Your System; VA12 Weight Loss; and VA13 Medicine for Diabetes.

ANALYSIS AND INTERPRETATIONS

The age of the responder on the efficacy and advantages of yoga practitioners in Chennai is displayed in Table 1.1. Only persons between the ages of 20 and 40 made up 47.5 per cent of the population, which is the study's greatest proportion of respondents by age. The age group of participants who had the lowest value in the table during the research 9 per cent were all over 80 and Above. They all freely agreed to do yoga and take advantage of its health advantages. 28.5 percent of the moderate percentage of the table 1.1 mentioned above, was only practiced by adults between the ages of 40 and 60 throughout the research. The data visualization reveals that 1.2 of the respondents were women who evaluated the efficacy and advantages of Chennai's yoga practitioners. 72 respondents were females, making up 48 percent of the respondents, the lowest percentage in the research. Male responses made up 52% of the total sample, or 78 people. The table displays the respondents' 1.3 monthly outlays for the efficacy and advantages of Chennai-area yoga practitioners. According to the data, 6.7 percent of respondents 10 in total spent between Rs 1001 and Rs 2000 per month on yoga. The percentage of 8.0 percent indicates that 12 respondents paid



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between Rs. 2001 and Rs. 3000 per month for yoga. According to the value of 26.7 per cent, 40 respondents were spending up to 1000 on yoga each month. The percentage of 58.7 percent indicates that 88 respondents spend 300 or more per month or more on yoga. The correlation analysis between the study's control variables and modifiable factors is displayed in the table. This table is only used to research the efficacy and advantages of yoga. The table demonstrates the degree of freedom and correlation values, indicating the link between the controllable variable and the controllable variables of age, gender, and monthly costs. VA1 doing yoga every single day. Making predictions, investigating and comprehending the connections between variables, and spotting trends in data may all be done with the help of correlation analysis. When analyzing correlation data, it's crucial to use caution and take into account additional aspects and potential confounding variables. A statistical term used to explain how closely or how quickly two variables move together is called correlation. It measures the magnitude and direction of the linear connection between two sets of data, to put it another way. Statistics, economics, social sciences, and natural sciences all frequently utilize correlation to examine and comprehend how changes in one variable may impact changes in another. helpful for your health include VA2 improve your flexibility, VA3 muscle building, VA4 protect your Spain, VA5 human bones, VA6 blood circulation, VA7 nerve system maintenance, VA8 mind relax system, VA9 cardio and circulatory health, VA10 injury protection, VA11 balance and relaxes you system, VA12 weight loss, and VA13 diabetes medication. The relationship between respondents' age, gender, and quantity spent on daily yoga practice that was beneficial to their health during the research was determined to have a correlation of 1.000.

This indicates a significant association between the control variable and VA1 throughout the trial. The computed correlation between respondents' age, gender, and spending amounts and VA2 improves flexibility is 0.946, indicating a strong association between the VA2 and Control variable. Yoga's benefits for strengthening muscle and the close association between the study's chosen variables and the control variables were used to compute VA 3. 1.000. This indicates a perfect correlation between the yoga's various components. It was the protect your Spain variable that had a strong association between the controlled factors age of the respondent and gender amount of the respondent, and the computed value of the VA4 was 1.000, which indicates that the controlled variables and selected variables had a strong relationship. The estimated value of the chosen variable VA5 human bones is 0.964, which indicates that 96.40% of the variables throughout the study had a relationship, meaning that respondents had a link between the chosen variables and the control variables. Since respondents had a relationship between the control variables and the selected variables during the study of yoga's benefits, the calculated value of the selected variable VA6 human bones was 0.971, which indicates that 97.70% of the variables had a relationship.

The estimated value of the chosen variable VA 7 maintained of nerves system is 0.964, which indicates a link between the variables during the study in which 97.10% of respondents reported such a relationship between the chosen variable and the control variables. The estimated value of the chosen variable VA 8 mind relax system is 0.964, which indicates a link between the variables during the research in which 94.60 percent of respondents reported such a relationship between the chosen variable and the control variables. The estimated value of the chosen variable VA 9 cardiac and circulatory health is 0.969, which indicates a link between the variables during the research in which 96.90% of respondents reported such a relationship between the chosen variable and the control variables. The estimated value of the chosen variable VA 10 protection of injury is 0.839, which indicates a link between the variables during the study in which 83.90% of respondents reported such a relationship between the chosen variable and the control variables. The selected variable VA 11 has a computed value of 0.938, which indicates a link between the variables during the research with 93.80% of respondents reporting a relationship between the control variables and the selected variables. The estimated value of the chosen variable VA 12 weight loss is 0.930, which indicates a relationship between the variables during the research in which 93,000 respondents participated. This indicates that respondents had relationships between the chosen variables and the control variables. The estimated value of the chosen variable VA 13 medication for diabetes is 0.964, which indicates a link between the variables during the study in which 94.60 percent of respondents reported such a relationship between the chosen variable and the control variables.





CONCLUSION

The researcher controlled the respondent's age, gender, and monthly costs in this study that was limited to the health advantages of yoga for people. Above these factors and relationships between the controlled variables, such as VA1 Daily yoga practise beneficial to health, VA2 improve flexibility, VA3 muscle building, VA4 protect your Spain, VA5 human bones, VA6 blood circulation, VA7 maintenance of nerves system, VA8 mind relax system, VA9 cardio and circulatory health, VA10 protection from injury, VA11 balance and relaxes you system, VA12 weight loss, and VA13 medication for the diabetes. All of these elements have a substantial correlation with the study's variables.

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Table 1: Age of the Respondent

Particulars	Frequency	Percent
20 to 40	95	47.5
40 to 60	57	28.5
60 to 80	30	15
80 and Above	18	9
Total	200	100

source : Computed From primary data.

Table 2: Gender of the Respondent

Particulars	Frequency	Percent
Female	72	48.0
Male	78	52.0
Total	150	100.0

Source; computed from primary dada.

Table 3: Monthly Expenses

Particulars	Frequency	Percent
Up To 1000	40	26.7
1001 To 2000	10	6.7
2001 To 3000	12	8.0
3001 and Above	88	58.7
Total	150	100.0

Source; computed from primary dada.





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Table 4: Correlations

Control Variables			VA 1	VA 2	V A 3	VA 4	VA 5	VA 6	V A 7	VA 8	VA 9	VA 10	VA 11	VA 12	VA 13
Age of the respondent Gender of the respondent Amount spent by the respondent	V A 1	Correlation	1.000	.946	.802	.921	.964	.971	.971	.946	.969	.839	.938	.930	.919
	1	DF	0	139	139	139	139	139	139	139	139	139	139	139	139
	V A 2	Correlation	.946	1.000	.838	.980	.967	.972	.972	1.000	.970	.824	.994	.884	.955
	2	DF	139	0	139	139	139	139	139	139	139	139	139	139	139
	V A 3	Correlation	.802	.838	1.000	.843	.817	.823	.823	.838	.805	.787	.834	.744	.808
	3	DF	139	139	0	139	139	139	139	139	139	139	139	139	139
	V A 4	Correlation	.921	.980	.843	1.000	.960	.964	.964	.980	.962	.810	.987	.880	.926
	4	DF	139	139	139	0	139	139	139	139	139	139	139	139	139
	V A 5	Correlation	.964	.967	.817	.960	1.000	.982	.982	.967	.989	.884	.943	.943	.929
	5	DF	139	139	139	139	0	139	139	139	139	139	139	139	139
	V A 6	Correlation	.971	.972	.823	.964	.982	1.000	1.000	.972	.982	.845	.964	.943	.943
	6	DF	139	139	139	139	139	0	139	139	139	139	139	139	139
	V A 7	Correlation	.971	.972	.823	.964	.982	1.000	1.000	.972	.982	.845	.964	.943	.943
	7	DF	139	139	139	139	139	139	0	139	139	139	139	139	139
	V A 8	Correlation	.946	.955	.838	.980	.967	.972	.972	1.000	.970	.824	.994	.884	.955
	8	DF	139	139	139	139	139	139	139	0	139	139	139	139	139
	V A 9	Correlation	.969	.970	.805	.962	.989	.982	.982	.970	1.000	.883	.973	.927	.935
	9	DF	139	139	139	139	139	139	139	139	0	139	139	139	139
	V A 10	Correlation	.839	.824	.787	.811	.884	.845	.845	.824	.883	1.000	.825	.823	.867
	10	DF	139	139	139	139	139	139	139	139	139	0	139	139	139
	V A 11	Correlation	.938	.994	.834	.987	.959	.964	.964	.994	.973	.825	1.000	.873	.948
	11	DF	139	139	139	139	139	139	139	139	139	139	0	139	139
	V A 12	Correlation	.930	.884	.744	.880	.943	.943	.943	.884	.927	.823	.873	1.000	.894
	12	DF	139	139	139	139	139	139	139	139	139	139	139	0	139
	V A 13	Correlation	.919	.955	.808	.926	.929	.943	.943	.955	.935	.867	.894	.894	1.000
	13	DF	139	139	139	139	139	139	139	139	139	139	139	139	0

Source; computed from primary data





Formulation Development and Evaluation of Vitamin D₃, Myoinositol and Folic Acid Oral Sachet

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ABSTRACT

This study provides a comprehensive overview of the formulation development and evaluation of an oral sachet containing Vitamin D₃, Myoinositol, and Folic Acid. This study covers the different types of granules used for medication and the process of granulation. It also discusses the benefits of using an oral sachet as a dosage form, including ease of use and improved patient compliance. It includes detailed information on the ingredients used in the sachet and how they work together to provide health benefits. It also includes outlines the steps involved in the formulation process and analytical results of the confirmatory batch. The oral sachet is a usefully enhanced technology that addresses the shortcomings of previous vitamin formulations. Three batches in total were made for the oral sachet. A pharmaceutical evaluation was conducted on each formulation. The developed sachets (F1, F2, and F3) were contrasted with commercially available sachets that had the same concentration of folate acid, myo inositol, and vitamin D₃.

Keywords: granules, vitamin D₃, myoinositol, folic acid, sachet

INTRODUCTION

The pharmaceutical dosage forms classified into four categories: solids, semi-solids, liquids and gases. Most of the medications are developed for an oral administration in a solid dosage form, like tablets, capsules, powders and granules. Granules are solid oral dose forms made of dry powder particle aggregates containing one or more



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medications with or without excipients. Granules are used in medicine in a variety of forms, including effervescent, coated, gastro-resistant, and modified-release. They are mostly used for high-dose, low-toxicity medications and can be taken as is, dissolved in water, or dispersed in foods. The process of converting a powdery or solid material into grains or granules, or granular material, is known as granulation. Granulation usually consists of the agglomeration of tiny particles into bigger granules, which can range in size from 0.2 to 4.0 mm, depending on the purpose that they will be put to. It commonly involves shredding or grinding of solid material into pellets or fine granules. In wet-granulation lines, water is continuously sprayed into the cutting chamber to lubricate the steel blades and remove debris and impurities. In dry granulation water is absent, but the output from these systems is typically of lower quality than that of wet systems. This process is relatively easy, the process needs to be carefully parametrized because friction causes high temperatures that can damage materials and change their plasticity. The scissor blades need to be sharpened on a regular basis, and the process needs to be closely watched because it could jam or clog.[1][2]

ADVANTAGES OF GRANULES DOSAGE FORM

1. Granules dosage form is more versatile and easier to administer, especially for patients, both adult and pediatric, who have trouble swallowing tablets or capsules.
2. It is possible to coat or prepare the granules for enteric or sustained release. It is convenient to take and can also be used to dispense drugs in large dosages.
3. Granules are suitable for industrial production because they don't require coating or punching tools, and their simple process makes them easy to use.
4. Because of their moisture-free formulation, granules are also appropriate for medications that are susceptible to moisture. Since the granules must first disintegrate before the drug dissolves, their dissolution rate is higher than that of tablets or capsules.
5. The chemical stability of granules and powders is higher than that of liquid dosage forms. When given as pharmaceutical powders or granules, it allows for the quick dissolution of medication in the stomach.
6. Compared to powders, granules are more suitable for compression and flow through the hopper regularly and freely.
7. The compressibility of granules is increased by their smaller surface area compared to powders. Most drug types are appropriate for granulation.[3][4]

Disadvantages of granules dosage form

1. Granules have a lower level of comfort for the patient when dispensed and carried than tablets or capsules, which is their main drawback.
2. Formulating hygroscopic or deliquescent, amorphous, oxygen-sensitive, volatile active pharmaceutical ingredients (API) can be challenging.
3. An experienced individual is needed to carry out the granulation process.
4. These medications require specific storage conditions; to avoid moisture degradation, they should be kept dry.
5. Given that granules have a constant dose, high precision, and minimal variability, their dosage may not be as exact as that of tablets, pills, or capsules.
6. It is an expensive technique because it involves multiple processing steps and requires more time, energy, and space.
7. Granules are not a good choice for administering potent drugs in low doses; instead, producing tablets and capsules is a better choice for low-dose drugs.
8. It is unable to mask the unpleasant taste and smell of the medications.



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MATERIALS AND METHODS

Excipients used in the formulation

Vitamin D3 (Fermenta), Myo inositol (Zhucheng), Folic acid (Sri Krishna), Glyceryl monostearate (Alfa chemistry), Butylated hydroxyanisole (Shiv Shakti india), Butylated hydroxytoluene (Vinipul inorganis pvt.limited), Sugar (E.I.O parry), Colloidal unhydrous silica (Wacker), Ace sulphame potassium (Anbui), Citric acid anhydrous (Sunil), Sodium benzoate (Ganesh benzoplast), Trusil orange (IIF), Purified water (Qs).

MANUFACTURING PROCESS

S.NO	NAME OF INGREDIENT	LABEL CLAIM	OVERAGES	QTY/ SACHET (mg)		
				F1	F2	F3
1	Vitamin D3	600IU	50	9.000	99.306	9.000
2	Myo inositol	1500mg	Nil	1506.476	1506.476	1503.457
3	Folic acid	600mcg	15%	0.750	0.750	0.750
4	Glyceryl mono Stearate					90.000
5	Butylated hydroxyanisole					0.036
6	Butylated hydroxytoluene					0.270
7	Sugar			1924.374	1832.568	1736.281
8	Colloidal unhydrous silica			30		
9	Ace sulphame potassium			4.200	4.200	4.200
10	Citric acid unhydrous			3.500	1.000	1.000
11	Sodium benzoate			0.700	0.700	0.700
12	Trusil orange			21.00	30.000	30.000
13	Purified water			300	300	300
14	Colloidal silicon Dioxide				25.000	25.000

FORMULATION 1 (F1)

Binder solution is prepared by dissolving vitamin D3 in 6ml of water stirred until well. Dissolve folic acid in 6ml of water stirred until well. Mix the binder solution and folic acid solution continuously stirring until get a clear solution. Sifted myo inositol through 30# and add the prepared binder solution to the above blend and mix gently to get the desired granules. The prepared wet granules loaded into tray drier at 60 C .The loss on drying of wet granules reaches into below 1%.Dried granules are sifted through 30# and check the weight of dried granules. Sifted sugar, colloidal Silicon dioxide, ace sulphame potassium, sodium benzoate, citric acid anhydrous through 30# named as A. Sifted trusil orange through 60# named as B. Mixing of A&B material. The final mixed material and dried granules into polybag and blended for 20 minutes.





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FORMULATION 2 (F2)

Glyceryl monostearate, butylated hydroxyanisole, butylated hydroxytoluene, vitamin D3 are taken for conical flask and kept in hot plate at 80-90 and stirred continuously until adsorbate preparation. Binder prepared by dissolving folic acid in 14g of purified water. Myoinositol Sifted through 30# and add the binder solution to the above sifted material and mix gently to get the desired granules. Prepared wet granules are loaded into tray drier at 60° and LOD reaches into below 1%. Dried granules sifted through 30# and sugar, colloidal Silicon dioxide, ace sulphame potassium, sodium benzoate, citric acid anhydrous through 30#. Truissl orange Sifted through 60#. Loaded the above three materials are loaded into polybag and blended for 20minutes (200 Rotation). Final granules are filled into empty sachets.

FORMULATION 3 (CONFIRMATORY BATCH (F3))

Binder is prepared by dissolving 1.2g of folic acid in 300g of purified water. Sifted 2405.532g of Myo inositol through 30# mesh and that material loaded into rapid mixer granulator at 10L capacity. Discharge wet granules are loaded into tray drier at 60°C and dried granules are passed through 30# mesh. To check the loss on drying of above the sifted granules (LOD=0.602%) and again granules are loaded into tray drier at 60°C for 20 minutes. To take one teaspoon of dried granules at place of tray drier to check the loss on drying (LOD=0.155%). Vitamin D3 adsorbate prepared by glyceryl monostearate, butylated hydroxyanisole, butylated hydroxytoluene, vitamin D3 are transferred into conical flask. The conical flask kept in to hot plate at 80-90°C and continuously stirred to get the form of adsorbate. The adsorbate sifted through 30# mesh. Weight of vitamin D3 adsorbate was 77.25g. Lubricant prepared by sugar, colloidal Silicon dioxide, ace sulphame potassium, sodium benzoate, citric acid anhydrous, truissl orange are sifted through 30# mesh. Transfer the above dried granules, vitamin D3 adsorbate, and sifted lubricated materials into octagonal blender (10L) and blended for 20 minutes. Weight of lubricated blend was 2710g. The final step is binder, vitamin D3 adsorbate and lubricant was loaded into polybag and blended for 20mins. Final granules filled into empty sachets.

ANALYTICAL RESULTS OF CONFIRMATORY BATCH (F3)**Assay of folic acid**

The folic acid was determined by HPLC method using 0.68ml trifluoroacetic acid in 1000ml of water used as mobile phase and C18 column was used. UV detectors used for detection at the wavelength of 283nm. The percentage purity of folic acid was 116.7 %.

Assay of vitamin D3

Assay of vitamin D3 done by HPLC method. 0.68ml trifluoroacetic acid in 1000ml of water used as mobile phase and C18 column was used. UV detectors used for detection at the wavelength of 268nm. The percentage purity of vitamin D3 was 164.1%.

Assay of Myoinositol

Myoinositol was determined by using HPLC method. 0.68ml trifluoroacetic acid in 1000ml of water used as mobile phase and C18 column was used. The percentage purity of myoinositol was found to be 161%.

SUMMARY & CONCLUSION

The excipients of the formulation were identified, and their levels were optimized based on empirical approach. Impact of quantities of emulsifying agent (Glyceryl monostearate), antioxidants (Butylated hydroxyanisole and butylated hydroxytoluene) Colloidal anhydrous silica (Glidant), Preservative (citric acid anhydrous), Sweetening agent (sugar), provide sweeteners (Ace sulphame potassium) and Antifungal agent (sodium benzoate), flavouring agent (truissl orange) was evaluated on drug product critical parameters. The formulation composition was finalized based on the knowledge gained from these studies. The work has demonstrated that successful formulation of oral sachet disease of 'Polycystic ovarian syndrome'. From the experimental studies result, it can be concluded that, oral sachet of vitamin D3, Myoinositol and folic acid are formulated to increase shelf life of this formulation and thereby improve its therapeutic efficacy. Oral sachet containing Vitamin D3 prepared by adsorbate method, Myoinositol and



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follic acid were prepared by wet granulation method and their evaluation were carried out. Oral sachet is improved beneficial technology to overcome the limitation of other Vitamin formulation. Total of three batches were prepared for Oral sachet. All the formulations were subjected to pharmaceutical evaluation. The formulated sachet (F1,F2 and F3) were compared with marketed sachet containing the same strength of vitamin D3, Myo inositol, folic acid.

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RESEARCH ARTICLE

Gas Chromatography-Mass Spectrometric Metabolites Analysis of Fungal Endophytes from Alpan Banana as Reservoir of Phytochemicals

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ABSTRACT

The *Aspergillus* species is classified as a heterotrophic saprobiont organism that engages in competitive interactions with other microorganisms, hence impeding their growth and development. The fungus exhibits many methods of action, including the synthesis of antibiotics and metabolites, as well as hyperparasitism, which also facilitates the stimulation of systemic resistance in plants. This research aimed to analyse. The aim of this study was to determine the secondary metabolites synthesised by indigenous strains of *Aspergillus* spp. that were isolated and characterized from ripe/unripe banana in controlled laboratory settings. The secondary metabolite production was done in Czapek's liquid medium for a duration of 6 days at a temperature of 28 ± 1 °C, with continuous agitation at a rate of 160 revolutions per minute. The resulting filtrates were subjected to three extractions with ethyl acetate (EtOAc) using liquid-liquid separation method. The residues were dissolved in ethyl acetate and analyzed by gas chromatography-mass spectrometry (GC-MS) analysis. The use of gas chromatography-mass spectrometry (GC-MS) revealed that the *Aspergillus* isolates synthesized a total of 42 and 37 secondary metabolites by AM1 and AM2 consisting of volatile and semi-volatile molecules. It was discovered that the number of compounds varied depending on the species under investigation as well as the specific location from where the isolates were collected.

Keywords: Endophytes, GC-MS, aspergillus, secondary metabolites, MZmine

INTRODUCTION

In recent times, there has been a significant emphasis within the scientific community on the advancement of novel antibiotics, antivirals, chemotherapeutic drugs, and pesticides. This pursuit involves harnessing the bioactive characteristics of microbial products (Dewick, 2002; Newman and Cragg, 2012; David *et al.*, 2014). Fungi are often



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recognised as promising sources for the production of a wide range of structurally varied natural products, which may be used either in their original form or as novel structural templates (Schulz *et al.*, 2002; Keller *et al.*, 2005). Many of these metabolites possess a broad variety of antibacterial activity in addition to other qualities that are useful in the pharmaceutical industry (Song *et al.*, 2021). Endophytic fungi are microorganisms that are contained inside plant tissue without causing any overt signs of illness (Pál *et al.*, 2021). They are a significant source of several secondary metabolites that are physiologically active (Moghaddam *et al.*, 2021) such as tannins, flavonoids, coumarins, alkaloids, polyphenols, peptides, lactones, phenylpropanoids, terpenes, polyketides, and lignans (Mulla *et al.*, 2021). This makes them an important source of secondary metabolites. Fungal endophytes are a natural source of newly discovered compounds that are physiologically active and have important implications for the medical field (Newman and Cragg, 2016). More than seventy percent of anticancer and antibacterial medicines generated from endophytes fungus are physiologically active natural chemicals or their derivatives (Newman and Cragg, 2020). Biologically active chemicals were shown to have considerable effects on immunological illnesses including diabetes and hypocholesterolemia, as well as difficulties associated to oxidative stress. In addition to this, they are useful for improving crops and mitigating the damaging effects of abiotic stressors (Khan *et al.*, 2015).

Aspergillus species are widely distributed opportunistic moulds that may induce both allergic and invasive symptoms. The taxonomic classification includes about 180 species, out of which 33 have been linked to diseases in humans (Segal *et al.*, 2004; Perfect *et al.*, 2002). According to previous studies conducted by Bellini *et al.* (2003) and Anupama *et al.* (2007), *Aspergillus niger* has been identified as the third most prevalent species linked to cases of invasive pulmonary aspergillosis. *Aspergillus niger* is of significant economic and biotechnological importance because to its widespread utilisation in the manufacture of extracellular enzymes and organic acids, including citric acid (Baker, 2006; Perrone *et al.*, 2007; Mogensen *et al.*, 2010). In addition, it generates fumonisin B2 (FB2) in conjunction with OTA. 9, 19, 27. Fumonisin is believed to be responsible for toxicities in both humans and animals, and are considered to have carcinogenic properties (Susca *et al.*, 2010; Chacko *et al.*, 2012; Gebreselema *et al.*, 2013). The cultivation of *Aspergillus* spp. in a culture has the potential to facilitate the diagnosis of invasive aspergillosis. Moreover, it can provide valuable information regarding appropriate treatment options through susceptibility testing or the identification of a species that exhibits intrinsic resistance to antifungal agents. Notably, *Aspergillus terreus* and *Aspergillus nidulans* are examples of such species, as they are known to be resistant to amphotericin B (Walsh, 2004). One prominent drawback associated with culture is its inherent sluggishness, since the procedure necessitates a considerable amount of time, sometimes spanning several days. Additionally, culture exhibits a very limited sensitivity, potentially hindering its ability to accurately detect certain species. Moreover, the successful execution of culture demands specialised knowledge in species detection, further complicating its implementation. Gas chromatography coupled to mass spectrometry (GC-MS) is an established method that has promising potential for effective use in metabolome investigations (Jonsson *et al.*, 2005; Kopka, 2006). Indeed, it offers a very convenient instrument to circumvent the often-intricate techniques required for the adequate isolation of metabolites in substantial levels of purity. The use of gas chromatography-mass spectrometry (GC-MS) as an analytical approach offers distinct benefits in terms of its ability to accurately and consistently identify chemicals present in intricate matrices, displaying exceptional sensitivity and reproducibility (Schauer *et al.*, 2005).

Fungal secondary metabolites are significant natural compounds derived from fungal organisms. Fungi have been shown to create a substantial number of volatile chemical compounds that remain unidentified. The vast array of fungal species, many of which remain undiscovered, along with the limited amount of study conducted on fungal metabolites, positions fungi as a very promising reservoir of valuable substances with potential uses in biotechnology, pharmacology, medicine, agriculture, and industry. According to Blackwell's estimate (Blackwell, 2011), the global population of fungal species exceeds 5.1 million. However, the investigation of secondary metabolite synthesis has been limited to a small fraction of these species (Strobel and Daisy, 2003; Strobel, 2014).

Fungal secondary metabolites refer to organic substances that do not play a role in the typical growth and development processes of fungus (Tamano, 2014). In contrast to primary metabolites, secondary metabolites do not serve as essential components for the survival of an organism. Instead, they are often synthesised in significant



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quantities during an organism's transition from the active growth phase to the stationary phase (Agostini *et al.*, 2012). The metabolites mentioned play many roles in the biological processes of their host species, including defence against predators, illnesses, parasites, bio-control of pathogens, and communication between microorganisms and their environment (Netzkeret *et al.*, 2015 and Vinaleet *et al.*, 2008). Fungal metabolites have shown use as pharmaceutical agents with anti-cancer, anti-oxidant, anti-viral, immunosuppressive, and immunomodulatory properties (. Pandi *et al.*, 2013; Li *et al.*, 2015; Marson *et al.*, 2015; Mizerska-Dudkaet *et al.*, 2015).

The objective of this work was to determine the volatile secondary metabolites generated in liquid culture of *Aspergillus nomius* KUB105, an endophytic microfungus that was identified during a survey of microfungi. Gas Chromatography-Mass Spectrometry (GC-MS) was used for this purpose.

MATERIALS AND METHODS

Microorganism Cultivation and culture conditions

Samples of fruit peel and pulp, weighing about 2.0 g each, were collected using a sterile scalpel. The samples were then pulverised in a sterile mortar and pestle, and 10 ml of a sodium chloride solution (0.5%) was added during the grinding process. One millilitre aliquots of each suspension were inoculated onto three distinct media: Potato Dextrose Agar (PDA), Meat Peptone Agar (MPA), and Gause's medium. The infected plates were sterilised and placed in Petri dishes. Subsequently, the Petri dishes were incubated at a temperature of 28.0 ± 0.2 °C for a duration of 6 days. Subsequently, a visual examination was conducted on the Petri plates, and hyphae originating from separate colonies were introduced onto fresh Petri plates with Potato Dextrose Agar (PDA). These plates were then incubated until the growth of unique colonies was seen. Following incubation, the pure cultures were placed onto Potato Dextrose Agar (PDA) slants and then kept at a temperature of 4 °C until they were used for further experiments. The identification of endophytic microorganisms was facilitated by the use of both macroscopic and microscopic methods. The macroscopic examination of endophyte morphology included the observation and characterization of several colony attributes, including shape, size, colour, and hyphal structure. The examination of slides, which were made from a tiny section of fungal mycelium and dyed with methylene blue, was conducted using an Ulab XY-B2T LED microscope at a magnification of 40×. The microscope was connected with a trinocular attachment, allowing for the connection of a digital camera-eyepiece.

Production and extraction of secondary metabolites by *Aspergillus* strains

The endophytic fungi obtained from the peel (*Penicillium* sp. I) and pulp (*Penicillium* sp. II) of the fruits were cultured under submerged circumstances. In this experiment, a tiny portion of PDA slants containing fungal mycelium was inoculated into a 500 mL Erlenmeyer flask. The flask was filled with 200 mL of Czapek's liquid medium, which had been sterilised by autoclaving at a temperature of 121 °C for a duration of 40 minutes. Following the inoculation, the medium underwent incubation for a duration of 6 days at a temperature of 28 ± 1 °C, with continuous agitation at a rate of 160 revolutions per minute. Subsequently, the biomass of mycelia was isolated from the aqueous solution by filtering using a Whatman No. 1 filter. The resulting filtrates were subjected to three extractions with an equivalent amount of ethyl acetate (EtOAc) using a separating funnel. The ethyl acetate extracts were combined and subjected to evaporation at a temperature of 40 °C using a rotary evaporator (IKA® RV 10, Germany). The resulting solid fraction was then kept at a temperature of 4 °C until being analysed. The mycelium biomass was pulverised and combined with ethyl acetate. The resulting mixture was subjected to a 24-hour period of darkness, followed by filtration and subsequent evaporation until dryness was achieved. The residues were dissolved in ethyl acetate and then filtered through a syringe filter in preparation for bioassays and gas chromatography-mass spectrometry (GC-MS) analysis.

GC-MS Analysis and Compound identification

The sample was diluted in methanol and afterwards introduced into a Shimadzu® GC-MS QP2010 model. The gas chromatography (GC) analysis was performed using an SH-I-5Sil MS capillary column with dimensions of 30m x



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0.25mm x 0.25um. The injection mode used was splitless. The experimental parameters used for the analysis in the gas chromatography-mass spectrometry (GC-MS) setup were as follows: The oven was first set at a temperature of 45 °C for a duration of 2 minutes. Subsequently, the temperature was increased to 140 °C at a rate of 5°C per minute. Finally, the temperature was further raised to 280 °C and maintained at this level for a period of 10 minutes. The volume of the sample injection was 2 µL, whereas the carrier gas used was helium at a flow rate of 1 mL/min. The ionisation of the sample components was conducted at an energy level of 70 electron volts (eV). The duration of the gas chromatography (GC) procedure ranged from 9.10 minutes to 52.0 minutes. The NIST14.L library (2020) was then used to conduct a comparative analysis of the chemical structures with those present in the NIST database. The identification of chemicals was then conducted by comparing the retention durations and mass spectra of the samples with those of recognised compounds in the NIST library (C:\Database\NIST14.L).

Data Processing and Statistical Analysis

The raw data files acquired from GC-MS runs were transformed into the NetCDF (network Common Data Format) format, which is independent of the manufacturer. The data processing was conducted using version 0.60 of the MZmineprogramme (<http://mzmine.sourceforge.net/>). The processing pipeline of MZmine encompasses many steps, including input file modification, spectrum filtering, peak identification, chromatographic alignment, normalisation, visualisation, and data export. Each of these phases is governed by a set of parameters.

RESULT AND DISCUSSION

In both the fungal endophytic isolates aspergillus species were identified. Based on preliminary macroscopic and microscopic analysis, the endophytes have been identified as *Aspergillus* spp. Species were identified by molecular characterization method using ITS gene as *aspergillus flavus* and *Aspergillus fumigatus* reported in our previous work. The findings from the gas chromatography-mass spectrometry (GC-MS) examination of ethyl acetate extracts from the culture medium of *Aspergillus flavus* (AM1) revealed the presence of 42 chemicals (tabulated in table 1) that may be classified into several chemical classes. The chemicals with the highest abundance, as shown in Table 1, are (Z)-3-Phenyl-2-propenoic acid, 2-Propenoic acid, 3-(2-methoxyphenyl)-, Coumarin, 13-Docosenamide, (Z)-, p-Cresylglycidyl ether, gamma-Sitostenone, trans-o-Coumaric acid, O-methoxycarbonyl-, n-Hexadecanoic acid, 4H-Pyran-4-one, 2, 3- dihydro-3, 5- dihydroxy- 6,1- (4 - Hydroxy- 3- methoxyphenyl) dec - 4- en -3 - o, Cyclopropa[5,6]-A-nor-5.alpha.-androstane-3, 3-Phenylpropanol, 3'-hydroxy-6'-methylsulfon Sydonol, dimethyl ether (E)-1-(4-Hydroxy-3-methoxyphenyl)dec-3-en-, Nootkaton-11,12-epoxide, Methylprednisolone Acetate, 1-(4-Hydroxy-3-methoxyphenyl)tetradec-4-en, 1,2-Cyclopentanedione, Phenol, 4-methoxy-2-nitro-, Oleic Acid, (E)-3,3'-Dimethoxy-4,4'-dihydroxystilbene, 1-Naphthalenepropanoic acid, 1,2,3,5,6,7,8,8a, gamma.-Sitosterol, 9,12-Octadecadienoic acid (Z,Z)-, Tetradecanoic acid, Isolinderenolide as shown in figure 1.

The study of second *Aspergillus* isolate, the ethyl acetate extracts by GC-MS mostly identified 37 chemical compounds from various classes, with a major presence of acids, esters, and alcohols (refer to Table 2). The primary components of the ethyl acetate (EtOAc) extracts consisted of some most notable constituents were 1-(4-Hydroxy-3-methoxyphenyl)dec-4-en-3-o, 3-Decanone, 1-(4-hydroxy-3-methoxyphenyl)-, 9,12-Octadecadienoic acid (Z,Z)-, Oleic Acid, gamma.-Sitostenone, n-Hexadecanoic acid, (E)-4-(2-(2,6-Dimethylhepta-1,5-dien-1-yl), (+)-cis-Verbenol, acetate, Spiro[4.5]dec-6-en-1-ol, 2,6,10,10-tetramethy, Spiro[4.5]dec-6-en-1-ol, 2, 6, 10, 10-tetramethy, 3-Decanone, 1-(4-hydroxy-3- methoxyphenyl) -, Tetracos-2, 6, 14, 18, 22- pentaene-10,11-diol, 2, 2,10-Bisaboladiene-1,4-diol, 3-Decanone, 1-(4-hydroxy -3- methoxyphenyl)-, (3R,5S)-1-(4-Hydroxy -3- methoxyphenyl) deca, 1-(3, 4-Dimethoxyphenyl) decane-3,5-diyl diac, 1-(2,4-Dihydroxyphenyl)-2-(4-nitrophenyl)eth, 13-Docosenamide, (Z)-, (E)-4-(2-(2,6-Dimethylhepta-1,5-dien-1-yl), 7-(2-Hydroxypropan-2-yl)-1,4a-dimethyldecah, 3-Decanone, 1-(4-hydroxy-3-methoxyphenyl)-, Octadecanoic acid, 2(3H)-Furanone, dihydro-3,4-bis[(4-hydroxy-, 1-Isobutyl-7,7-dimethyl-octahydro-isobenzofu, gamma.-Tocopherol, 3-Chloropropionic acid, 2-phenylethyl ester, 1,3-Cyclohexadiene, 5-(1,5-dimethyl-4-hexeny, (E)-1-(4-Hydroxy-3-methoxyphenyl)tetradec-3,3-(2,5-Dimethyl-1H-pyrrol-1-yl)-4 hydroxybe, Propanoic acid, 2-methyl-, 1-methyl-1-(4-meth, (E)-1-(4-Hydroxy-3-methoxyphenyl)dec-3-en-, 4-Nitrobenzoic acid,



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heptadecyl ester, Cyclohexene, 3-(1,5-dimethyl-4-hexenyl)-6-m, Hexahydro-3-(1-methylpropyl)pyrrolo[1,2-a]p,Bicyclo[3,3,1]non-2-ene,7-oxa-2,8,9 trimethy, (+)-cis-Verbenol, acetate, Matridine

The ethyl acetate extract of metabolites from 2 different aspergillus species included the following principal components: 9, cis-13-Octadecenoic acid, methyl ester, 10-Octadecenoic acid, and methyl ester, which all belong to a category of oleic acid esters that have anti-cancer, anti-inflammatory, choleric, and anemiagenic properties (Sheeba *et al.*, 2019). These properties were revealed due to the presence of a large number of phytoconstituents, including a variety of octadecanoic acid methyl esters. When tested against clinically relevant microorganisms, hexadecenoic acid methyl ester had the greatest antibacterial activity (Shaaban *et al.*, 2021). The secondary metabolites extract of aspergillus included fatty acid methyl esters, which demonstrated antibacterial and antifungal activity (Sati *et al.*, 2016). The secondary metabolites extract of aspergillus also had a composition of fatty acids, such as pentadecanoic acid, which is a saturated fatty acid. Dimethyl phthalate has the potential to alter the shape of cell membranes and disrupt the normal opening and closing of membrane channels. Both di (2-ethylhexyl) phthalate and di-n-butyl phthalate, known to be effective against a wide variety of bacterial strains (Roy *et al.*, 2006). Phthalates have the potential to impede the growth of gram-positive bacteria such as *S. epidermidis* and *S. aureus*, as well as gram-negative bacteria such as *E. coli*, *P. aeruginosa*, and *Klebsiella pneumoniae*. The antibacterial effects of di (2-ethylhexyl) phthalate on *B. subtilis* (Habib and Karim, 2009) and the antifungal activities of di (2-ethylhexyl) phthalate against *C. albicans* (Shanab *et al.*, 2010) may be found in the plant as well as bacterial sources. There have been reports that di-n-butyl phthalate may limit the development of mycelium as well as the germination of spores in the fungi *Colletotrichum musae*, *Gaeumannomyces graminis*, and *Colletotrichum gloeosporioides* (Liu *et al.*, 2020; Liang *et al.*, 2020). The metabolite also shown to contain primary alcohols with long chains which is a synthetic combination of six different compounds (1-tridecanol, 1-pentadecanol, 1-heptadecanol, 1-nonadecanol, and 1-eicosanol, and 1-tricosanol). The extract can be used to make medicines. Antibacterial activity was established by *S. amplexicaulis* leaves in reports at much lower concentrations (Chatterjee *et al.*, 2017). The present work demonstrated that *Aspergillus flavus* and *fumigatus* spp. possess a rich source of active metabolites with fatty acids, phenols, and flavonoids that may enhance the ability of these species spreading in many pharmaceutical applications. The GC-MS analysis showed abundant content from total lipids, monounsaturated fatty acids, and total unsaturated fatty acids in the extract. Our method was effective, and its application might further be investigated as the potential source of secondary metabolites produced by filamentous fungus.

CONCLUSION

The identification of several bioactive chemicals presents in the ethyl acetate extract of *Aspergillus* sp., which was cultured from the fruit of ripe and unripe banana, was verified via the use of gas chromatography-mass spectrometry (GC-MS) analysis. A total of 42 in *Aspergillus flavus* extract and 37 in *Aspergillus fumigatus* volatile chemicals were identified, with around six of these components exhibiting considerable biological activity. Nevertheless, conducting phytochemical screening and isolating specific compounds, followed by rigorous biological activity testing, is expected to provide more significant findings. This approach will also pave the way for exploring other components and their potential pharmaceutical applications, hence expanding the scope of inquiry.

Ethics declarations

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable

Data availability statement: All data generated or analysed during this study are included in this published article

Ethical statement: No animals were harmed during this study

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Conflicts of interest

The authors state that there is no conflict of interest





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Table 1: Metabolites identified in extracts from endophyte fungus sample 1 (AM1)

S.No.	R.Time	F.Time	Area	Area%	Height	Height%	Compound name
1	23.699	23.755	85614599	14.79	4829737	3.49	(Z)-3-Phenyl-2-propenoic acid
2	30.568	30.745	30691445	5.3	4041162	2.92	2-Propenoic acid, 3-(2-methoxyphenyl)-
3	22.976	23.09	24960111	4.31	5768703	4.17	Coumarin
4	45.47	45.635	23396269	4.04	8199141	5.93	13-Docosenamide, (Z)-
5	26.756	26.95	22205271	3.84	4627468	3.35	p-Cresylglycidyl ether
6	47.159	47.32	18256902	3.15	1971539	1.43	.gamma.-Sitostenone
7	22.307	22.505	17983484	3.11	2046406	1.48	trans-o-Coumaric acid, O-methoxycarbonyl-
8	34.636	34.71	17097014	2.95	5731127	4.15	n-Hexadecanoic acid
9	14.671	14.765	13120092	2.27	2769424	2	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6
10	40.357	40.47	11206725	1.94	3718501	2.69	1-(4-Hydroxy-3-methoxyphenyl)dec-4-en-3-o
11	32.628	32.715	10816103	1.87	4261067	3.08	Cyclopropa[5,6]-A-nor-5.alpha.-androstane-3,
12	44.939	45.015	10719632	1.85	4158666	3.01	3-Phenylpropanol, 3'-hydroxy-6'-methylsulfon
13	44.065	44.095	9440094	1.63	3835450	2.77	Sydonol, dimethyl ether
14	45.975	46.11	9392681	1.62	1657759	1.2	(E)-1-(4-Hydroxy-3-methoxyphenyl)dec-3-en-
15	32.588	32.605	8957758	1.55	3698337	2.68	Nootkaton-11,12-epoxide
16	33.14	33.205	8893946	1.54	3256103	2.36	Methylprednisolone Acetate
17	44.799	44.875	8353136	1.44	2431187	1.76	1-(4-Hydroxy-3-methoxyphenyl)tetradec-4-en
18	8.012	8.11	8103262	1.4	2469754	1.79	1,2-Cyclopentanedione
19	31.085	31.235	7754543	1.34	1147543	0.83	Phenol, 4-methoxy-2-nitro-
20	37.379	37.515	7774237	1.34	2306933	1.67	Oleic Acid
21	44.236	44.41	7622469	1.32	1441297	1.04	(E)-3,3'-Dimethoxy-4,4'-dihydroxystilbene





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22	32.094	32.145	7453332	1.29	3204306	2.32	1-Naphthalenepropanoic acid, 1,2,3,5,6,7,8,8a
23	42.701	42.76	7433541	1.28	1248674	0.9	.gamma.-Sitosterol
24	37.263	37.315	6705006	1.16	2030639	1.47	9,12-Octadecadienoic acid (Z,Z)-
25	31.98	32.05	6474375	1.12	2155740	1.56	Tetradecanoic acid
26	43.794	43.875	5786399	1	2163659	1.57	Isolinderenolide
27	42.168	42.24	5506247	0.95	2158210	1.56	E,E-3,13-Octadecadien-1-ol
28	39.267	39.34	5460319	0.94	1752741	1.27	3-Decanone, 1-(4-hydroxy-3-methoxyphenyl)-
29	38.738	38.835	5182041	0.9	1266289	0.92	1,3-Diisobutyryn, TMS derivative
30	33.75	33.8	4765405	0.82	2302901	1.67	(3S,3aS,6R,7R,9aS)-1,1,7-Trimethyldecahydr
31	25.918	26.06	4310020	0.74	668263	0.48	Oxirane, [(2-methylphenoxy)methyl]-
32	47.399	47.51	4290854	0.74	899499	0.65	Allylescaline
33	21.311	21.425	4224763	0.73	1197613	0.87	Hydrocoumarin
34	44.114	44.175	4190621	0.72	2029851	1.47	Z-8-Methyl-9-tetradecen-1-ol formate
35	28.007	28.13	3849246	0.66	548665	0.4	Ethyl mandelate
36	41.621	41.685	3739520	0.65	1627538	1.18	5-Hydroxy-1-(4-hydroxy-3-methoxyphenyl)de
37	33.471	33.5	3610771	0.62	1796717	1.3	1,1,6-trimethyl-3-methylene-2-(3,6,9,13-tetram
38	9.548	9.615	3417204	0.59	1344938	0.97	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-on
39	16.938	17.08	3363599	0.58	754731	0.55	4-Vinylphenol
40	41.02	41.085	3299160	0.57	924883	0.67	1-Naphthalenepropanol, .alpha.-ethenyldecahy
41	19.292	19.325	2913982	0.5	1228678	0.89	2-Propen-1-ol, 3-phenyl-
42	36.818	36.875	2923750	0.5	1153942	0.83	1-Octadecanol, methyl ether

Table 2: Metabolites identified in extracts from endophyte fungus sample 2 (AM2)

S.No.	R.Time	F.Time	Area	Area%	Height	Height%	Compound name
1	40.474	40.505	220428125	9.8	38359911	6.65	1-(4-Hydroxy-3-methoxyphenyl)dec-4-en-3-o
2	42.674	42.705	118315307	5.26	25593878	4.44	3-Decanone, 1-(4-hydroxy-3-methoxyphenyl)-
3	37.471	37.515	117702504	5.23	13472216	2.34	9,12-Octadecadienoic acid (Z,Z)-
4	37.574	37.735	80558922	3.58	14245139	2.47	Oleic Acid
5	47.191	47.345	65487876	2.91	7975778	1.38	.gamma.-Sitostenone
6	34.77	34.835	62097721	2.76	17219990	2.99	n-Hexadecanoic acid
7	49.95	50.115	54144396	2.41	11382011	1.97	(E)-4-(2-(2-(2,6-Dimethylhepta-1,5-dien-1-yl)
8	34.69	34.715	45554623	2.03	17014893	2.95	(+)-cis-Verbenol, acetate
9	39.883	39.95	38253777	1.7	11984464	2.08	Spiro[4.5]dec-6-en-1-ol, 2,6,10,10-tetramethy
10	39.186	39.245	37924403	1.69	9476190	1.64	Spiro[4.5]dec-6-en-1-ol, 2,6,10,10-tetramethy
11	39.318	39.465	37512763	1.67	9737140	1.69	3-Decanone, 1-(4-hydroxy-3-methoxyphenyl)-
12	32.692	32.735	35247117	1.57	15577532	2.7	Tetracos-2,6,14,18,22-pentaene-10,11-diol, 2
13	33.471	33.575	31100143	1.38	10218193	1.77	2,10-Bisaboladiene-1,4-diol
14	40.992	41.08	27700853	1.23	6538231	1.13	3-Decanone, 1-(4-hydroxy-3-methoxyphenyl)-



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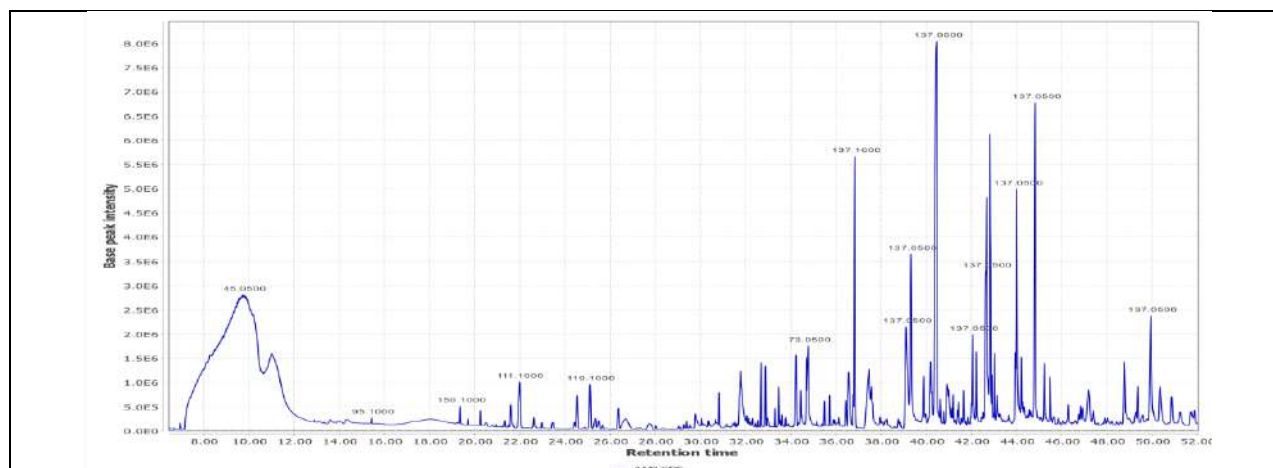


Figure 2: Total ion chromatogram of extracts from endophyte fungus sample 2 (AM2)

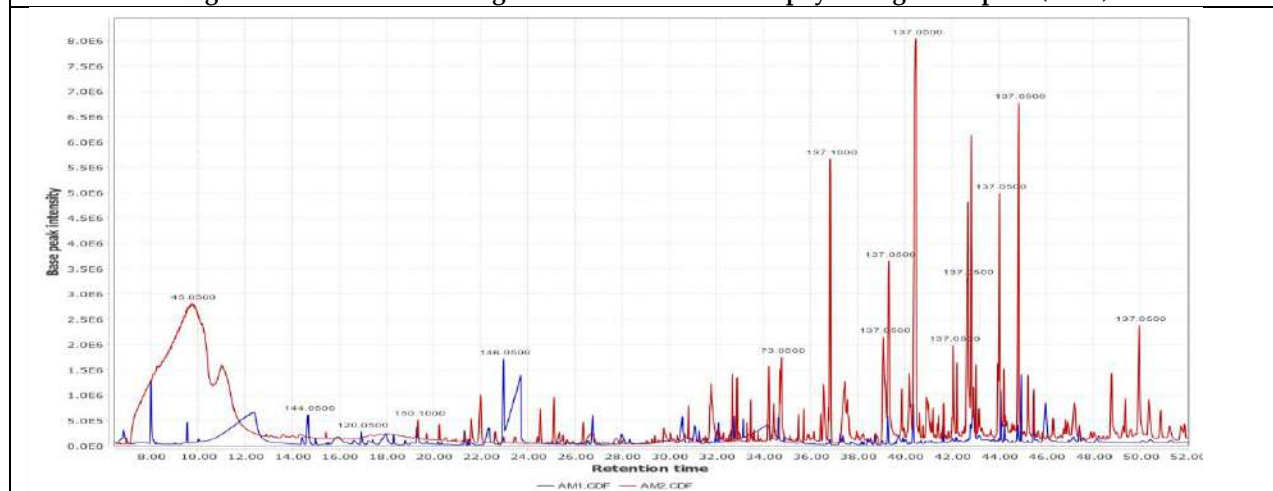


Fig 3: Overlaid TIC of metabolites identified in extracts from endophyte fungus sample 1 and 2 (AM1 and AM2)





RESEARCH ARTICLE

A Critical Appraisal of Dark Triad Personality, Emotional Intelligence and Attachment Style of Adolescents: A Correlational Study

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ABSTRACT

It is believed that knowing the core ethical attitude in life is an individual's emotional capacity, which is referred to as emotional intelligence in psychological literature. It is a fascinating subject because it explores many aspects of personality and aids in understanding and managing one's attachment styles. This paper focuses on the relationship between emotional intelligence, dark triad personality, and attachment style in adolescents. Adolescents is the population from which the sample is obtained. A total of 250 adolescents in the ninth and tenth grades were chosen at random. This paper can be a guide to parents and teachers in providing sufficient knowledge on how emotional intelligence can become a tool in living a fulfilling life ahead. In the present study, correlation is used to decipher the relation between emotional intelligence, dark triad personality and attachment style. Correlation between the sub-variable of emotional intelligence and dark triad personality and attachment style was also deduced. The results showed that there is a significant negative correlation between emotional intelligence and dark triad personality and its sub-variables. But emotional intelligence does have a positive relation with attachment style and its sub-variables. The findings of the study can be a tool for teachers and parents in educational institutions.

Keywords: Dark Triad Personality, Emotional Intelligence, Attachment Style, Adolescents

INTRODUCTION

Personality is a Greek word derived from the word 'persona'. It basically refers to a mask which Greek actors used to put for their acts for portraying different personalities of the characters. According to layman's perspective, personality could be anything that is put up on a display in terms of values, education, learning, experiences, a





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person gains during his/her life (Jonason, Webster, Schmitt, Li, & Crysel, 2012). It is the mirror to the world that exists beyond the appearance of the individual. A good personality is supposed to exist when an individual is able to impress others and is able to gel with other people. Those who don't possess such abilities are supposed to have poor personality. For a non-psychology individual personality often refers to overt characteristics (Twenge & Campbell, 2003). For instance, if an individual is good looking, he/she may have a good personality. On the contrary, psychology defines personality beyond an individual's visible characteristics. Over characteristics like shy, friendly, caring etc are the components of personality which may or may not be present in a given situation. In this sense, personality refers to the individual characteristics which remain constant over a period of time. A standard definition of personality in psychology is- 'the unique, relatively enduring internal and external aspects of person's characteristics that influence behaviour in different situations.' Once we are able to know someone's personality, we can predict his/her behaviour. In psychological literature, the term dark triad is used to denote the personality traits of narcissism, psychopathy, and Machiavellianism. The fact that these factors hold up malevolent qualities is the reason why they are called 'dark' (Lee & Ashton, 2005). Up until now most of the research are applied in the field of business management, law enforcement and clinical psychology. It is believed that people high on these qualities are most likely to commit crimes, inflict harm to others and can be a severe threat to the society. These factors if found in people are likely to be less compassionate, socially withdrawn and disobeying. The three factors of dark triad seem to be overlapping but if studied deeply, will come out as distinctive features.

Narcissism: an individual high of narcissism will have lack of empathy, grandiosity; egotism etc. there is an intense pursuit of gratification. Superego seems to be highly abnormal in people with narcissism. The severe form of narcissism culminates into narcissistic personality disorder.

Psychopathy: an individual high on this factor will be antisocial, callous, and unemotional trait. it is interchangeably used for the term sociopathy. Traditionally speaking, if an individual is high on psychopathy, he/she will fall under the boundary's personality disorder.

Machiavellianism is characterized by exploiting others, manipulating others and, higher level of self-interest and an absence of morality. Manipulativeness is one other striking feature in Machiavellianism. High on Machiavellianism is supposed to have high level of deceitfulness and unempathetic temperament.

Emotional Intelligence

Emotional quotient commonly abbreviated as EQ is the ability to use emotions wisely so as to relieve stress, to excel, to get support and give support. Fattah, A. (2020). It can also help oneself to convert intentions into actions and actions into consistent efforts to be successful in life. (D'Amico & Geraci, 2022). Daniel Goleman once rightly said EQ is a better indicator of one's success than intelligence quotient. What we can comprehend by this is that it's not IQ that makes the person smartest/successful instead EQ. Emotional intelligence is usually attributed to four basic components-

Self-Awareness: it comes when an individual is aware of his/her emotions. An individual high on self-awareness knows why he/she is feeling the emotions. Such an individual knows their strength and weakness. They engage themselves in honing their strengths rather than sulking or cribbing about their weakness.

Self-Management: As the name suggests, it means to manage one's emotions. It is very important in today's world to manage your emotions. A person high on this, will be able to seek support and give support in times of crises. Such an individual will be able to control negative emotions like greed, frustration, anger, jealousy.

Relationship management: This is one of the most important components in a corporate sector. Relationship management tool comes handy to anybody who wants to go higher in the hierarchy. Relationship management means to maintain one's relation with others in order to get help and provide help to anyone and everyone.

Social awareness: Lot of people gets confused between social awareness and relationship management. Social awareness however means to have empathy, pick up emotional cues, to make the other person feel comfortable etc.

Attachment Style

The development of attachment style is credited to Bowlby. He based his theory on Freud's concept of love (Bifulco *et al.*, 2016). Drawing parallels, Bowlby defined attachment style as a long-lasting connection among beings.



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Bowlby believed in the psychoanalytic viewpoint which posits that childhood insecurities and fear bloom in the personality in later ages (Jones & Cassidy, 2014). Thus, he believed that children's attachment style with their parents play an important role in the development of the personality. Our attachment styles are developed through the love and care we get from our primary and secondary caregivers.

There are four major characteristics of attachment style.

- Separation anxiety occurs in the absence of the primary care giver.
- Safe haven is feeling a child has when he/she returns to caregiver for care and security in the face of threat.
- Proximity maintenance is the innate desire to be near the primary care giver.
- Security base is when the primary caregiver acts as a security on the basis of which a child can explore the surrounding.

On the basis of these characteristics, three important propositions were developed. First, children are less likely to experience fear when they have the confidence that their primary care givers are there to respond their needs. Secondly, it is believed that this confidence is laid down in the critical period of development, the expectations formed during this period remains unchanged for rest of the life. Thirdly, these expectations are based on experiences. If children have an experience that their care givers were responsive in the past, they'll be responsive to the expectations in the future as well.

There are four attachment styles in the psychological literature which are explained below:

- Secure attachment-as the name suggests the child here has maximum level of attachment due to the security of care, love, and understanding given to them. The foundation of secured attachment style can bloom trust, high self-concept, empathy, and self-awareness in a child.
- Insecure attachment- under this, the primary and secondary caregivers do not meet the needs and expectations of the child as a result the child's emotional and psychological development is arrested or delayed.
- Anxious attachment-when a care giver is inconsistent in responding to the needs and expectations of the child, the child may develop confused personality.
- Disorganised attachment- this is one where a child's needs and expectations are not only ignored but they have a sense of fear attached to their caregivers. Such children ignore their priorities and don't respond instantly.

REVIEW OF LITERATURE

The study of emotional intelligence possesses a lot of challenges due to its multi-dimensional property of growing intrinsically and self-regulatory throughout the life span (Thompson 1991). There is little or no research on adult development of emotional intelligence. However, in childhood and adolescents, the scope of emotional intelligence can be traced. The emotional intelligence in adults is directly proportionate to individual goals in life and how well one is using defence mechanism to cope with life. It can be learnt how emotional development of adolescents from high school theatre programs (Larson and Brown 2007). The authors concluded that organized programs like group counselling, school clubs and theatre programs provide a valuable microcosm for providing an in depth understanding about their level of emotional intelligence. all the three dark triad traits, show a considerable facilitation towards explosive social tactics. This study is the first to declare a link between three dark triads and risk behaviour. It is also affirmed that there exists a positive association between the three dark triads and sensation seeking as well as impulsive behaviour (Crysel, Crosier *et al.* 2013). It is concluded by (Malesza and Ostaszewski 2016) that narcissism and psychopathy accounts significant levels of variance within self-reported risk behaviour. Risk taking tendency in psychopathy is attributed to psychopathic syndrome such as impulsivity, sensation seeking, anti-social tendencies and erratic lifestyle. It is assumed that personality and social psychologist has a lot to research when it comes to understanding attachment style of adolescents (Waters, Crowell *et al.* 2002). Bowlby's and Ainsworth's theory of attachment style has a lot to offer in terms of understanding the personality of an adolescent. place where parents and teachers fail to cope with temper tantrum problems, that's where the psychologists come in



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place. It has been observed that the first tool they use as a measure to deal with the situation is to study the attachment style between the parent and the adolescent. This foremost step facilitates the process of counselling.

founded that there are certain attachment styles like secure and preoccupied are predicted to bring improvement in psychopathy, depending on the severity of the case. The protective environment provided during the counselling gives a scope of improvement of behaviour (Gerlsma and Luteijn 2000). One of the important domains in emotional intelligence is the understanding of other's emotions. This research extended the previous studies in different views which was unique in psychological literature. Under this study, separate association of both vulnerability narcissism and grandiosity, primary and secondary with managing the emotions of others (MEOS) was studied. (Petrides, Vernon *et al.* 2011). The conclusion affirms the previous findings of MEOS stating that agreeableness was highly correlated with pro-social behaviour towards others and all the three components of dark triad personality was linked to interpersonal manipulations. This research done by (Rauthmann and Kolar 2012) came up with an idea to measure how 'dark' Narcissism, Psychopathy, Machiavellianism are. The researchers were also keen on understanding how lay person perceive dark triad, do they distinguish between the three types of dark triad or not. Surprisingly, people saw narcissism as an exception as they did assume some positive qualities in narcissistic personality.

The researchers argued that one's career assessment can be solidified by judging his/her emotional intelligence. (Zeidner, Matthews *et al.* 2004) they affirm many of the popular claims in the psychological discourse which states that emotional intelligence is a far better indicator of job success as compared to intelligence. Researchers also pointed out that most of the emotional intelligence scales used in the cooperate sector overlaps with personality scales. Thus, there is an urge of developing an independent instrument for the same. This study proclaims much popular belief that emotional intelligence is one of the most important criteria of job satisfaction. (Akomolafe and Ogunmakin 2014) this particular research was done on the schoolteachers. The conclusion pointed to the vicious cycle of low emotional intelligence of schoolteachers impacting the performance of the students. One of the most sophisticated studies was done by (McWey 2004) on foster children. They had avoidant attachment style and thus, they primarily depended on themselves. It was also seen that when a potential caretaker comes in their lives, the don't show any signs of trust. The children may also behave as if they don't require any help. After scrutinising, the researchers claim that this attitude came primarily from emotional abandonment from their origin families.

In the recent years the most drastic changes in family have occurred due to rising rates in divorce (Sirvanli-Ozen 2005) as a consequence, children are developing flawed attachment style namely avoidant and ambivalent attachment style. The research came up with astonishing results stating that the impact of divorce on children varies on the basis of the gender of the child as well as the fact that are they staying with the parents they like along with the support they receive from teachers and friends in the school. important implications were drawn from the present study. The authors held the viewpoint that education on emotional intelligence must be infused in graduate and undergraduate nursing program. The authors not on put emphasis on the learning part but also on the practicality of the curriculum. They argued that self-awareness and new behaviours must the fostered in nurses. The study put forward the suggestions to increase the emotional intelligence in nurses however, the success of these suggestions is to be researched further (Beauvais, Brady, O'Shea, & Griffin, 2011).

METHODOLOGY

In the present research a correlational design is used. Correlational analysis will help to determine the relationship between emotional intelligence, dark triad personality and attachment style. 250 adolescents are used for this study. Purposive sample is used. Adolescents studying in class 8th 9th and 11th were undertaken for the purpose of the present study. Pearson r correlation analysis is applied with the help of SPSS. Instruments for collecting data are- a) The Schutte Self Report Emotional Intelligence Test (SSEIT) b) Dark Triad of Personality (D3-Short), c) Attachment Style Questionnaire.



**Geetika Mishra and Meenakshi Joshi****Hypotheses**

There will be a positive relation between secure attachment style and emotional Intelligence among adolescents.

There will be a negative relation between fearful attachment style and emotional Intelligence among adolescents.

There will be a negative relation between dismissive attachment style and emotional Intelligence among adolescents.

There will be a negative relation between pre-occupied attachment style and emotional Intelligence among adolescents.

There will be a negative relation between psychopathy and emotional Intelligence among adolescents.

There will be a negative relation between narcissism and emotional Intelligence among adolescents.

There will be a negative relation between Machiavellianism and emotional Intelligence among adolescents.

RESULTS AND ANALYSIS

Table 1 Shows the Pearson correlation (r) between Emotional Intelligence and sub-variables of Attachment Style and Dark Triad Personality. For computing the correlation, SPSS was used. The correlation between Emotional Intelligence and secure attachment style is 0.867, which is a significant positive correlation. The correlation between Emotional Intelligence and fearful attachment style is -0.551, it shows a significant negative correlation. -0.642, a significant negative correlation was found between emotional intelligence and pre-occupied correlation. And the correlation between emotional intelligence and dismissive attachment style was significant negative too with -0.859. As far as the correlation between emotional intelligence and three sub-variables of dark triad personality i.e. Machiavellianism, Narcissism and Psychopathy is concerned all have significant negative correlation, -0.608, -0.634, -0.707 respectively.

DISCUSSION

The discussion will follow the pattern of hypotheses. Seven hypotheses are there in the present study. The first hypothesis is that There will be a significant relation between emotional Intelligence and secure attachment style among adolescents. (H_1). According to table 1.1 (results and analysis) of this paper, the relationship between the two variables is 0.867** which points towards positive significance. (Yahya, 2020). It means that emotional intelligence and secure attachment style is directly proportionate. In lay man's language it can be said that if secure attachment style increases, emotional intelligence also increases. Two key psychological concepts—attachment style and emotional intelligence—have a substantial impact on an adolescent's relationships, self-awareness, and general well-being. The discussion intends to examine the connection between emotional intelligence and secure attachment styles while highlighting the significance of understanding how these connections affect social interactions and emotional control. (Fraley, Garner & Shaver, 2000). The second hypothesis is that there will be a negative relation between emotional Intelligence and fearful attachment style among adolescents (H_2). There are particular difficulties in controlling emotions and navigating relationships when emotional intelligence and a fearful attachment style are combined. Often resulting from uneven or traumatic caregiving experiences, fearful attachment, often referred to as disordered attachment, is characterized by conflicting impulses for connection and dread of intimacy. People who have a fearful attachment style might have trouble controlling their emotions and have trouble comprehending themselves. Hence, there is a negative significant relation between fearful attachment style and emotional intelligence of -0.551. However, with time and assistance, they can recover and gain emotional intelligence. The third hypothesis is that There will be a negative relation between dismissive attachment style and emotional Intelligence among adolescents. (H_3). Adolescents who have been raised with a dismissive attachment style avoid emotional connections with others, thus, they often fall short in accepting relations with others and often misinterpret other's emotions towards themselves. Adolescents who are dismissively attached could have trouble navigating their emotional terrain, which makes it hard for them to establish and sustain good relationships. The emotional complexity linked to a dismissive attachment style may benefit greatly from interventions targeted at enhancing emotional intelligence, especially in the areas of self-awareness and emotion control. For those with a dismissive attachment type, increasing emotional intelligence may help with better interpersonal dynamics and a deeper sense



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of self. (Mikulincer & Florian, 1997). The fourth hypothesis in the present study is that there will be a negative relation between pre-occupied attachment style and emotional Intelligence among adolescents (H_4). The Pearson correlation between pre-occupied attachment style and emotional intelligence is -0.859 which means there is a negative significance between the two variables. A complicated interaction between emotional understanding and relationship dynamics is revealed by the association between emotional intelligence and a preoccupied attachment style, which is defined by an intense need for intimacy combined with concerns of abandonment. (Kobak & Sceery, 1988; Mikulincer & Florian, 2001) Preoccupied adolescents frequently struggle with self-doubt and are hyper-vigilant to interpersonal signs. They also frequently want validation and reassurance. Developing self-awareness, empathy, and effective interpersonal skills are all components of emotional intelligence, which is essential for overcoming the difficulties posed by a preoccupied attachment style.

There will be a negative relation between psychopathy and emotional Intelligence among adolescents is the fifth hypothesis (H_5). Adolescents frequently don't exhibit the same level of emotional reciprocity in social situations as people with higher emotional intelligence. While successful social interactions and excellent relationship outcomes are linked to emotional intelligence, psychopathy is distinguished by a conspicuous lack of these attributes. In both therapeutic and forensic settings, it is important to comprehend how emotional intelligence and psychopathy interact because therapies aimed at reducing the negative effects of psychopathic behaviours on relationships and society may require to address emotional processing deficiencies. There are clear linkage between emotional intelligence and psychopathy since those who possess psychopathic tendencies frequently lack emotional intelligence and empathy. Lack of regret, superficial emotions, and a decreased ability to build real emotional bonds with people are traits of psychopathy. On the other hand, emotional intelligence includes the capacity to identify, control, and comprehend one's own emotions in addition to being able to comprehend and react to those of others (Cooke & Michie, 2001; Cooke, Michie, Hart, & Clark, 2004). Those who are psychopathic usually have trouble in these areas, showing a diminished capacity to perceive and react correctly to emotional cues. The sixth hypothesis is that there will be a negative relation between narcissism and emotional Intelligence among adolescents (H_6). When it comes to narcissism, adolescents may be very self-aware yet find it difficult to identify and understand the feelings of those around them. (Emmons, 1987). Their concentration is on self-centred goals and lack of true empathy may come through in their dealings with others. In order to fully comprehend the social and emotional dynamics that define adolescents with narcissistic traits, it is imperative to understand the complex relationship between emotional intelligence and narcissism. The seventh hypothesis is that There will be a negative relation between Machiavellianism and emotional Intelligence among adolescents (H_7). The interplay between interpersonal strategic manipulation shapes the link between emotional intelligence and Machiavellianism. Machiavellian adolescents are defined by their crafty and manipulative attitude to social relationships, frequently putting their own interests before of moral considerations. emotionally intelligent is knowing how to identify, comprehend, and control one's own and other people's feelings. (Furnham, Richards, & Paulhus, 2013; Paulhus & Williams, 2002). According to Machiavellianism, those with great emotional intelligence may use it strategically in strategic situations. Their ability to read and manipulate people's emotions may be exploited to take advantage of circumstances for one's own benefit.

CONCLUSION AND SUMMARY

An adolescent's psychological composition includes both their emotional intelligence, dark triad personality and attachment type. Although more emotionally intelligent people tend to have stable attachment styles and is said to have better personality traits, the relationship between these three variables is complex and goes beyond this simple correlation. Although an individual's attachment style can affect their emotional intelligence and personality, this relationship is not deterministic because emotional intelligence is a lifelong skill that can be mastered. To promote healthier relationships and personal development, understanding this relationship might be helpful.





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Table 1 Correlation between Emotional Intelligence and sub-variables of Attachment Style and Dark Triad Personality.

	Emotional Intelligence	Secure Attachment Style	Fearful Attachment Style	Pre-Occupied Attachment Style	Dismissing Attachment Style	Machiavellianism	Narcissism	Psychopathy
Emotional Intelligence	1							
Secure Attachment Style	0.867**	1						
Fearful Attachment	-0.551	-0.547*	1					





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Style	**							
Pre-Occupied Attachment Style	- 0.642 *	-0.639**	0.797**	1				
Dismissing Attachment Style	- 0.859 **	-0.808*	0.572*	0.650**	1			
Machiavellianism	- 0.634 **	-0.704**	0.379*	0.464*	0.594*	1		
Narcissism	- 0.608 **	-0.704*	0.379**	0.464**	0.594**	1	1	
Psychopathy	- 0.707 **	-0.704**	0.379**	0.464*	0.594**	1	1	1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (1-tailed).





A Mathematical Assessment on the Impact of Obesity

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ABSTRACT

Obesity and its consequences are a significant cause of sickness, and their effects on quality of life and mortality can be profound. Numerous disorders, including cancer, the metabolic syndrome, diabetes, etc., are linked to obesity. Depending on the type of breast cancer and the menopausal stage, there is a complex relationship between obesity and the chance of developing the disease. This article studies the impact of obesity in breast cancer and brain tumour mathematically.

Keywords: mathematical model, obesity, mortality, breast cancer, body mass index, brain tumour.

INTRODUCTION

Overweight and obesity are caused by a variety of reasons including behaviours such as eating patterns, lack of sleep or physical exercise, certain medications, genetics, and family history. People with overweight or obesity are more likely to develop a wide range of significant illnesses and medical disorders than people with a healthy weight [4]. Obesity increases your risk of having high cholesterol and blood pressure. Heart disease or stroke risk is increased by either of those disorders. A significant risk factor for type 2 diabetes is obesity. Obese people are approximately 6 times more likely to have high blood sugar. Gallstones and gallbladder disease are more prevalent in obese people. Obesity has been related to cancers of the kidney, oesophagus, endometrium (the lining of the uterus), colon, and breast (after menopause). Additionally, several research have found connections between obesity and pancreatic, ovarian, and gallbladder malignancies. Hypertension, commonly known as high blood pressure, is largely brought on by obesity, according to experts [20]. About three out of every four people with high blood pressure have obesity [10]. Congestive heart failure (CHF), stroke, renal disease, and other illnesses are all made more likely by high blood



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pressure. Obese individuals have less lung capacity. They are unable to breathe in and out as much air. Asthma and other respiratory conditions are more common in these patients, as well as respiratory (lung) infections. Obese individuals have been demonstrated to have an increased risk of asthma by three to four times. It makes reasonable that obesity shortens lifespan or promotes premature mortality given the negative effects the condition has on numerous facets of health. But determining how much fat contributes to early mortality has been difficult due to methodological issues and debate. As BMI rose above the healthy range of 23.5 to 24.9 for males and 22.0 to 23.4 for women, there was an increased risk of mortality from all causes, cardiovascular disease, cancer, or other disorders [3]. Another meticulously controlled analysis of five prospective cohort studies [5] and a prospective study of more than 500,000 older men and women in the National Institutes of Health/AARP research both found a similar relationship between weight and death [1]. The implications of obesity on a variety of diseases have been the subject of several studies, but this article focuses on its role in breast cancer and brain tumour.

Obesity and brain tumour risk

The World Health Organisation (WHO) conducted a brain cancer survey, which revealed that brain cancer is a leading cause of mortality worldwide. Brain cancer is caused by an aberration in the life cycle of cells in the brain. These are anomalies in normal cells caused by the interaction of a person's genetic variables (also known as Primary brain tumour), age factor (also known as Secondary brain tumour), and carcinogens (physical/chemical/biological). Obesity raises the risk of developing brain cancers such as meningioma (a form of brain tumour). Excess body fat might alter the level of hormone secretion in the body. These hormones make proteins that are released into the blood, and the blood transports these hormones throughout the human body. Hormone fluctuations can have a wide-ranging impact on the body. It can also increase the risk of other types of cancer in the human body, including brain cancer. These aberrant fat cells can damage other cells in the body, including immune cells and brain structures. Furthermore, these immune cells create substances that cause damaging inflammation in brain cells. This cellular inflammation might endure for a long period. It may increase the risk of developing brain cancer. Given the rare nature of CNS tumours and the contradictory findings of the many investigations, the relationship between obesity and CNS tumours is still somewhat unclear. Recent data from six studies [15] were combined in a meta-analysis that specifically focused on meningioma; the authors came to the conclusion that being obese, but not overweight, was linked to an elevated risk for meningioma, particularly in females. However, to far no attempt has been made to quantitatively synthesise all published cohort and case-control studies in order to assess the possible link between obesity and glioma or other generalised brain/CNS tumours. In light of the aforementioned factors, Sergentanis TN. et.al. [14] thoroughly analyse and synthesise the evidence on the relationship between adult obesity and the risk of brain/CNS tumours, gliomas, and meningiomas.

Obesity's impact on breast cancer

Numerous epidemiological studies and meta-analyses have shown that obesity is associated with an increased risk of estrogen-receptor (ER)-positive breast cancer in postmenopausal women, as well as poor clinical outcomes independent of menopause status, when compared to their normal-weight counterparts. Aside from an increased chance of getting breast cancer, multiple studies have found that obesity is linked to poorer outcomes for breast cancer patients of all subtypes. Several meta-analyses have been conducted, and the results show a substantial link between obesity and higher breast cancer mortality. Obese patients had a 33% higher risk of death, according to one meta-analysis of 43 studies [12]. Obesity, as assessed by body mass index (BMI) or waist-hip ratio (WHR), is a risk factor for the development of new instances of breast cancer in postmenopausal women [13]. The evidence in premenopausal women is less clear: some evaluations found a mild negative connection with general obesity, as measured by BMI [18], while others found a favourable association with central obesity, as evaluated by WHR [6]. Obesity appears to have an impact on survival in women who have already been diagnosed with breast cancer. Fat is a metabolically active tissue that has a high concentration of the aromatase enzyme, which converts testosterone to oestrogen. Excess oestrogen production from expanded adipose tissue has been proposed as a possible mechanism for the poor outcomes in obese breast cancer patients. Obesity, on the other hand, is linked to worse disease outcomes in obese women with hormone-sensitive and hormone-resistant malignancies [7]. Furthermore, obesity is a





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risk factor for developing triple-negative breast cancer, implying that increased endogenous oestrogens are not the only cause leading to an increased risk of recurrence [21]. Being overweight or obese after menopause raises the risk of breast cancer in women. Increased adipose tissue can increase your risk of breast cancer by increasing oestrogen levels. Women who are overweight also have increased insulin levels, which is another hormone. Increased insulin levels have also been related to certain malignancies, including breast cancer. However, the relationship between weight and breast cancer risk is ambiguous. According to studies, the risk appears to be higher for women who gained weight as adults but may not be higher for those who have been overweight since infancy. Furthermore, having additional fat around the waist may increase risk more than having extra fat around the hips and thighs.

Mathematical assessment of obesity's impact

To identify effects of obesity on the risk of dying between 2001 and 2012, Alberto Palloni et.al. [2] estimated a fully parametric proportional hazard model with a Gompertz baseline hazard. The model for mortality over age 50 takes on the following form:

$$\mu(x_0 + t) = \lambda e^{((x_0 - 50) + t)\gamma}, \quad (1)$$

where x_0 is age at first wave (2001), t is the duration since first wave, λ is the Gompertz level parameter and γ is Gompertz's slope. The Gompertz function is a good approximation to mortality at ages over 50. They rescaled age to be the difference between age at first wave and 50. From (1) it is clear that the regression coefficient associated with the rescaled age variable, e.g., $(x_0 - 50)$ in the proportional hazard formulation must be constrained to equal the slope, γ . The parameter λ (an estimate of mortality at age 50) was modeled as a function of covariates, including controls for sex and (a dummy for) education, in addition to the variables of interest to us namely, obesity/overweight indicators and self reported conditions, particularly diabetes, cancer and heart diseases. The Gompertz model for mortality over age x takes on the following form:

$$\mu(x_0 + t) = \lambda e^{((x_0 - x) + t)\gamma}, \quad (2)$$

The survival function of (2) is given by

$$S(x_0 + t) = e^{-\frac{\lambda}{\gamma}(1 - e^{\gamma((x_0 - x) + t)})} \quad (3)$$

for a population of size N , the age at which the population has diminished to one survivor is

$$(S(x_0 + t) = \frac{1}{N}) \text{ approximates } t_m. \text{ Thus,} \quad (4)$$

$$S(t_m) \approx \frac{1}{N} = \exp\left\{-\frac{\lambda}{\gamma}(1 - e^{\gamma(t_m - x)})\right\}$$

or

$$t_m - x = \frac{\ln\left[1 + \frac{\gamma \ln N}{\lambda}\right]}{\gamma},$$

which in turn gives

$$t_m = \frac{\ln\left[1 + \frac{\gamma \ln N}{\lambda}\right]}{\gamma} + x. \quad (5)$$

From equation (5) we have

$$\gamma(t_m - x) = \ln\left[1 + \frac{\gamma \ln N}{\lambda}\right],$$

which in turn gives From equation (5) we have

$$e^{\gamma(t_m - x)} = 1 + \frac{\gamma \ln N}{\lambda}$$

Simplifying further we get

$$\lambda = \frac{\gamma \ln N}{e^{\gamma(t_m - x)}}. \quad (6)$$

The above equation gives an estimate for λ and it can be considered as any of the parameters (brain tumour or breast cancer), where N denotes the total affected population under study (either obese with brain tumour or obese with breast cancer), t_m is the maximum lifespan of the affected population and x denotes the age at which the person gets affected. Consider the right hand side of equation (6). It is of the form (comparing γ and)

$$y = x e^{-x}$$





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The first and second derivatives of the above equation are

$$\begin{aligned} y' &= x(e^{-x}) + e^{-x} \\ &= (1-x)e^{-x} \end{aligned}$$

and

$$\begin{aligned} y'' &= (1-x)(-e^{-x}) + e^{-x}(-1) \\ &= -e^{-x} + x(e^{-x}) - e^{-x} \\ &= (x-2)e^{-x} \end{aligned}$$

respectively. Hence the function has no minima and has a maximum value at 1. It can also be observed that the function is decreasing in $(-\infty, 1]$ and increasing in $[1, \infty)$. Also

$$\begin{aligned} \lim_{x \rightarrow \infty} xe^{-x} &= \lim_{x \rightarrow \infty} \frac{x}{e^x} \\ &= \lim_{x \rightarrow \infty} \frac{1}{e^x} \\ &= 0 \end{aligned}$$

and

$$\begin{aligned} \lim_{x \rightarrow -\infty} xe^{-x} &= \lim_{x \rightarrow -\infty} \frac{x}{e^x} \\ &= -\infty \end{aligned}$$

The graph of the function $y = xe^{-x}$ (see figure 1) is a smooth curve through the origin, maximum at $\left(1, \frac{1}{e}\right)$ and

levelling off to $y = 0$ but do not touch the line $y = 0$. As a consequence, the estimation in equation (6) indicates the relationship between obesity and other diseases (especially brain tumour and breast cancer). That is, when an obese person is affected by brain tumour or breast cancer, the impact is greater than when a non-obese person is affected. As a result, we can conclude that obese people who are affected by other diseases are at higher risk than non-obese people. It is clear from equation (5) that the maximum life span is determined by the ratio of the two parameters λ and γ . The behaviour of various indicators can reveal the difference in the maximum lifetime of fat and non-obese people with other disorders. This part provides analytical support for the evaluation. Unfortunately, due to a lack of data, we are unable to compare our results.

CONCLUSION

In this article, we derived an estimation by analytical method to find the effect of obesity in brain tumour and breast cancer. The statistical survey on the impact of obesity on various health issues undoubtedly predict many results that are beyond the scope of the present article. Future studies examining more elaborate indices of obesity, such as the waist to hip ratio as a marker of central obesity, or measurements of subcutaneous fat and whole body fat proportion, could provide additional insight into the underlying pathophysiological links. Future research may widen the scope of this meta-analysis by studying the connections of obesity with additional tumour types.

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Table 1: Obesity and Brain tumour risk (reprinted from [16])

Tumour type	Sex	Effect estimate (95%CI)	Heterogeneity
Brain/CNS Tumours	Female Male	1.19(1.05–1.36)	17.8%
		1.01(0.87–1.17)	36.1%
Meningiomas	Female Male	1.48(1.28–1.71)	0.0%



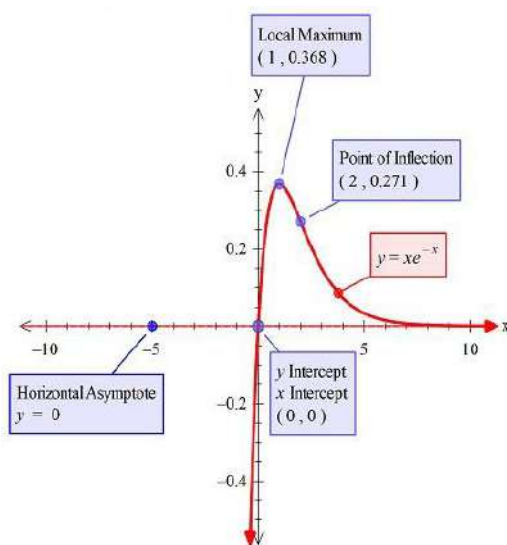


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		1.78(1.22–2.61)	29.6%
Gliomas	Female Male	1.13(0.92–1.38)	0.0%
		0.81(0.42–1.57)	49.5%

Table 2: Obesity and Breast Cancer risk

Study type	Findings	Reference
Prospective	RR1.45 (95%CI1.27–1.66) of ER+BC in womenwhogained25kgormoresinceage 18	[19]
Prospective	HR1.23 (95%CI1.15–1.35) for ER+BC in Women with a BMI>29	[17]
Meta-analysis	RR1.25 (95%CI1.07–1.46) for postmenopausal breast cancer in obese women	[8]
Meta-analysis	OR1.43(95CI1.23–1.65) for TNBC In obese premenopausal women	[6]
Meta-analysis	RR 1.41 (95% CI 1.29–1.53) for overall mortality for obese women RR higher in premenopausal women (RR1.75) then postmenopausal women (RR 1.34)	[11]
Meta-analysis	RR 1.37 (95% CI 1.20–1.57) of contralateral BC in obese women	[12]

Figure1: Graph xe^{-x} 



RESEARCH ARTICLE

Isolation and Biochemical Characterization of Potassium Solubilizing Bacteria from Rhizospheric Soil and their Effect on *Amaranthus blitum* L.

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ABSTRACT

Potassium (K) is the third essential element together with Nitrogen and Phosphorus for the plant growth metabolism and development of crop. Lack of potassium in the soil leads to poor development of roots, shoots, less branches. The production and management of biological fertilizers containing KSB can be an effective alternative to chemical fertilizers. The present study was planned to isolate and identify of potassium solubilizing bacteria (KSB) from rhizosphere soil Thiruvavur Dt, Tamilnadu, India. Rhizospheric Soil sample was collected from the selected fertile field, serial dilution performed and pot culture trial was performed for growth promotion of *Amaranthus blitum* L. Bacterial species were identified by Biochemical tests pure KSB screened and identified by Aleksandrow medium. Hence the bacteria were identified as *Bacillus* sp. The pot experimental was designed as control, inoculums of carrier based potassium solubilizing inoculants (*Bacillus* sp) with *Amaranthus blitum* L and liquid biofertilizer (*Bacillus* sp) with *Amaranthus blitum* L. Although liquid biofertilizer treated with *Amaranthus blitum* L showed the best result in (T3) height of the plant 40.6 ± 2.39 cm, number of leaves 42.6 ± 1.39 cm, shoot length 30.6 ± 1.39 cm, root length 15.6 ± 0.60 cm, number of roots 28.6 ± 0.40 cm, and yield also in 30th day. This article represented an overview of current trends and challenges on KSB, mechanisms and their role in plant growth promotion, and eventually gives some perspectives for research on K in agriculture. These results strongly suggested that potassium-solubilizing bacteria in the rhizosphere of *Amaranthus blitum* L. could improve potassium solubilization and uptake, and contributed to their success as an invasive



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species. Further studies should be performed to determine the optimal conditions of the stimulation KSB activity, such as the pH, organic matter and texture of soil under field trial.

Keywords: Potassium, *Bacillus* sp., Aleksandrow medium, *Amaranthus blitum* L.

INTRODUCTION

Potassium (K) is considered as an essential nutrient and a major constituent within all living cells. Naturally, soils contain K in larger amounts than any other nutrients; however most of the K is unavailable for plant uptake. Application of chemical fertilizers has a considerably negative impact on environmental sustainability. Nitrogen (N) and phosphorus (P), potassium (K) is the most important plant nutrient that has a key role in the growth, metabolism and development of plants. In addition to increasing plant resistance to diseases, pests, and abiotic stresses, K is required to activate over 80 different enzymes responsible for plant and animal processes. E.g. such as energy metabolism, starch synthesis, nitrate reduction, photosynthesis, and sugar degradation (Almeida *et al.*, 2015; CecilioFilho *et al.*, 2015; Gallegos-Cedillo *et al.*, 2016; Hussain *et al.*, 2016; White and Karley, 2010; Yang *et al.*, 2015). K is the seventh most abundant element in Earth's crust. Total K content in soils ranges between 0.04 and 3% K. Although K is present as an abundant element in soil, only 1 to 2% of this element is available to plants (Sparks and Huang, 1985). KSB can provide an alternative technology to make K available for uptake by plants. Thus, identification of efficient bacterial strains capable of solubilizing K minerals can quickly conserve our existing resources and avoid environmental pollution hazards caused by heavy application of K-fertilizers. Some bacteria like *Bacillus*, *Thiobacillus*, *Pseudomonas*, *Acidithiobacillus*, has been found to simplify and secret potassium from potassium-bearing complex minerals in soils. The potassium solubilization efficiency depends upon the nature of bacteria and condition of the mineral where it is servicing. Therefore, the yield of the crops can be increased by applying biofertilizer possessing Potassium containing minerals along with Ksolubilizing bacteria. The potassium fertilizers currently used in the agriculture region a great input that rocks them unaffordable by the farmer of developing nations. Since most soils are deficient in plant available Potassium and chemical fertilizers are not cost effective, Scientists they have a responsibility for society to find ways and means f makes natural Potassium resources available crops as an economically efficient substitute for expensive chemical fertilizers. Hence, this investigation is planned for the isolation and mechanisms of solubilizing K-bearing minerals to develop efficient bacterial inoculants for solubilization of K in soil and using as a liquid bio fertilizer in *Amaranthus blitum* L. which is one of the aims of achieving sustainable agriculture.

MATERIALS AND METHODS

Collection of soil (Atlas,2012)

Soil samples were collected from the agricultural field of Thiruvavur District, Tamilnadu, Indiagiven below Soil (Atlas, 2012). Five spots were fixed in a plot for taking one composite mixture of the soil. The surface of the field was scrapped away to obtain uniformly thick slice of soil from the plough depth from each place. A "V" - shaped cut was made with a spade to remove 1 to 2 cm slice of soil. The sample was collected in a clean bag and marked properly. The mouth of the bag was tied carefully. The same soil was also collected for pot culturing of the plants. Three replications were established in each location. One portion of the rhizospheric soil was kept at 4 °C for isolation of KSB within one day of collection, and the remaining soil was air dried for chemical analyses.

Adaptation and Enrichment

Soil samples collected from different regions of fertile area were mixed with Mica and kept at room temperature for one week. 1gm of soil sample and inoculate in 90 ml liquid media containing 0.95% glucose, 0.045% yeast extract and 0.45% Mica make final volume to 100ml and incubated at room temperature at 120 rpm for 7 days. Analysis of physicochemical parameters of the soil before and after. Treatment removing the debris, the soil samples was



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suspended in distilled water (1:2w/v) and allowed to settle down the sand particles. Physico-chemical parameters of soil such as pH, Temperature, Moisture, Electrical conductivity, Nitrogen, Phosphorus content were assessed by electrometric and turbidity method respectively (Jackson, 1973).

Isolation of potassium solubilizing bacteria from the soil sample**Serial dilution (Aneja, 2002)**

1 gram of soil sample was suspended in 10 ml distilled water. Serial dilution was preferred as per the standard procedure. The plates were incubated in an incubator at 37°C for 24 hours. The isolated bacterial strains were identified based on their cultural, morphological and biochemical characteristics to identify the bacteria (Cappuccino and Sherman, 1999). Biochemical tests were done.

Screening of KSB rhizosphere soil

KSB were isolated using solid Aleksandrow medium, which contained (per liter) 5 g glucose, 0.005 g $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 0.1 g FeCl_3 , 2.0 g CaCO_3 , 3.0 g potassium feldspar powder, 2.0 g calcium phosphate and 20 g agar-agar (Meena *et al.*, 2015). The plates were then incubated at 30 °C. After 7 days, each of the fast-growing colonies that showed a solubilization zone on the agar plates was considered to be KSB for the primary screening. The primary screened colonies were purified three times, and then K solubilization efficiency (KE) was calculated according to Khanghahiet *al.* (2018). $\text{KE} = \text{diameter of solubilization halo} / \text{diameter of the colony}$. The effective isolates were stored at 4 °C for future use. Optimum Conditions for Efficient growth and K Solubilization of bacteria (Anukriti Verma 2016). In order to determine the effect of different pH on the growth of isolated bacteria and zone of potassium solubilization the isolates were grown at pH range from 5, 6, 7, 8, 9. It was found that maximum growth and potassium solubilization was achieved at pH 7.0 with sharp decline in growth and potassium solubilization from pH 8 onwards. In order to study the optimum temperature for the growth of bacteria and its ability to solubilize potassium the isolated bacteria were grown on modified Aleksandrow medium broth at different temperature ranging from 25, 30, 35, 40, 45, 50 °C. It was found that bacterial strain showed maximum solubilization (5.0 cm) at 25 °C and decreased with increase in temperature. Hence the efficient species was identified as *Bacillus species* and it was used for pot culture trial.

Incubation of KSB on shaker

K-feldspar powder was added to liquid Aleksandrow medium as the sole source of K to test the ability of the isolates to solubilize the mineral. To further analyze the ability of KSB in solutions to solubilize K. The flasks with the Aleksandrow solution were sterilized by autoclaving at 0.1 MPa for 20 min. The cooled flasks were inoculated with 1 mL KSB solution. Uninoculated Aleksandrow solution was used as a control. Three flasks for statistical replication were used to incubate at 150 rpm and 28 ± 1 °C for 7 days. Available K content was measured on the 7th day.

Assessment of available K in the supernatant

The incubated solution containing KSB was diluted to 50 ml and centrifuged at 500 rpm for 10 min to eliminate insoluble materials. Ten milliliters of the solution was centrifuged at 10,000 rpm for 10 min to indicate the K content in the supernatant using flame spectrophotometer (Sugumaran and Janarthanam, 2007). Potassium chloride solution was used to prepare the standard curve.

Mass culture of KSB

Based on screening efficiency of KSB (*Bacillus sp.*) was used for pot culture treatment. These cultures were separately inoculated and incubated in 2 days for 500 ml conical flasks at 32 °C as submerged culture used to inoculate fresh media with inoculum load of 50% (v/v) using bioreactor.

Experiment Design

The efficacy test of identified KSB bacteria was done on pot culture trial basis. There is an increasing evidence to show that microbial inoculation of seeds may benefit plant growth through a number of mechanisms.



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Treatment 1: is Control.

Treatment 2: is Carrier based Potassium solubilizing inoculants (*Bacillus* sp) with *Amaranthus blitum* L

Treatment 3: is Liquid biofertilizer (*Bacillus* sp) with *Amaranthus blitum* L.

Morphological parameters

After treated with microorganisms, the Morphological parameters analyzed with standard procedure such as, Height of the plant (in cm), Number of leaves (per plant), Number of roots (per plant), Root length (in cm), Shoot length (in cm). The Biochemical components such as Protein, Carbohydrate, Chlorophyll, Carotenoid were analyzed by proper standard procedure.

RESULTS

Soil fertility and plant nutrition require an adequate management of essential macronutrients such as potassium (K) and phosphorus (P), which are mandatory for plant development. In the present study, The potassium solubilizing bacteria were isolated using culture medium and identified based on morphological and biochemical characteristics of potassium solubilizing bacteria were determined by Gram staining, biochemical and Bergey's Manual of systematic Bacteriology. The serial dilution and planting method was used for the isolation of bacterial colonies. The isolated bacteria KSB1 was identified as Gram positive, motile, rod shaped organisms (Table 1). The pH at the rhizosphere level was slightly more acidic compared to the non-rhizospheric soil, which was found closer to neutral. It was found that maximum growth and potassium solubilization was achieved at pH 7.0 with sharp decline in growth and potassium solubilization was achieved at pH 8 onwards. The water content indicated good moisture retention, while the organic matter levels were low. The total K contents determined in the non-rhizospheric soil was higher compared to the rhizospheric soil was higher compared to the rhizospheric soil, although both values were considered relatively high. Compared to control the study showed that there more production of KSB in liquid formulations. The pH at the rhizosphere level was slightly more acidic compared to the non-rhizospheric soil, which was found closer to neutral. These findings showed that *Bacillus* are promising candidates for the implementation of efficient bio fertilization strategies to improve soil fertility and plant yield under rock P and rock K fertilization. It can be concluded that K-solubilizing bacteria can be used as bio-inoculants, contributing to growth and yield increment of T3 treatment showed the increased level of height, number of roots, leaves and shoots, and chlorophyll content (Table 2- 4).

DISCUSSION

Our study agreed to Hassan Etesamiet.al., 2017 Potassium solubilizing bacteria (KSB): Mechanisms, promotion of plant growth, and future prospects - a review. K solubilization is carried out by a large number of bacteria such as *B. mucilaginosus*, *B. edaphicus*, *B. circulans*, *Pseudomonas*, *Burkholderia*, *Acidithiobacillus ferrooxidans*, and *Paenibacillus* sp. Our study correlated agreed to Feng et.al., 2020. Isolation and identification of potassium-solubilizing bacteria from *Mikania micrantha* rhizospheric soil and their effect on *M. micrantha* plants. In this study were to isolate and identify potassium-solubilizing bacteria and to evaluate their contribution to the solubilization of potassium from potassium-feldspar, and to the potassium uptake of *Mikania micrantha*. Potassium-solubilizing bacteria were isolated using solid Aleksandrow medium in abandoned orchards that have been highly invaded by *M. micrantha* for more than 10 years. Our results revealed that 18 strains of efficient bacteria were identified using liquid Aleksandrow medium.





CONCLUSION

Economically agricultural system has emerged as an important thrust area globally for in often soil environmental sustainability and to minimize the environmental pollutions associated with extensive use of chemical fertilizers. Therefore, PGPR along with the Nitrogen fixing phosphorus solubilizing bacteria and potassium solubilizing bacteria. Future study have to be taken for well-designed, large-scale and long term field trials are required to evaluate the feasibility of KSB application in increasing the availability of K and other nutrients and economic feasibility of different K sources should also be investigated.

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Table1: Morphological characteristics of potassium solubilizing Bacteria (KSB)

Morphological Characterization	<i>Bacillus sp</i>	<i>Pseudomonas aeruginosa</i>
Gram Staining	G+	G-
Motility	Motile	Motile
Shape	Rod	Straight curved, rod

Table 2: Analysis of parameters of soil sample Before and After treatment with KSB

Physico-chemical parameters	Before treatment	After treatment
pH	7.2	7.4
Temperature(°C)	7.4	8.5
Moisture (%)	62	64
Electrical conductivity(σ)	1.20-1.30	1.26-1.86
Phosphorus (P)mg/ml	38	60
Potassium(K)mg/ml	70	85
Carbon(C)mg/ml	0.78	0.99

Table 3:Promotional Effect of KSB on different morphological parameters in Amaranthusblitum L.

Treatments	Height of the plant (cm)	Number of leaves/plant	Shoot length (cm)	Root length (cm)	Number of roots/plant
T1	19.2 \pm 0.30	30.2 \pm 0.9	19.2 \pm 1.10	8.2 \pm 0.10	20.1 \pm 0.29
T2	35.3 \pm 1.35	39.5 \pm 1.20	25.3 \pm 1.20	10.3 \pm 0.30	25.3 \pm 0.32
T3	40.6 \pm 2.39	42.6 \pm 1.39	30.6 \pm 1.39	15.6 \pm 0.60	28.6 \pm 0.40

Values are represented as Mean \pm standard Deviation.

Table 4: Details of biochemical constituents in Amaranthus blitum L3

Treatment	Chlorophyll -a (mg/g)	Chlorophyll- b(mg/g)	Total Chlorophyll (mg/g)
T1	0.0420 \pm 0.040	0.0531 \pm 0.010	0.0430 \pm 0.001
T2	0.0520 \pm 0.050	0.0590 \pm 0.030	0.0500 \pm 0.020
T3	0.0621 \pm 0.057	0.0694 \pm 0.043	1.0655 \pm 0.626

Values are represented as Mean \pm standard Deviation.





Occurrence of Microplastics in the Gastrointestinal Tract of Two Edible Pelagic Fish Species *Megalaspis cordyla* and *Amblygaster sirm* Collected from the Chennai coast.

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ABSTRACT

Marine plastic pollution is increasing astonishingly due to overuse and inappropriate dumping of plastics into the ocean. When there is an abundance of microplastics (< 5 mm) in the water column, aquatic life unintentionally consumes plastics. This study examined commercial fish species like torpedo scad and spotted sardine from the Chennai coastal region for the presence and properties of microplastics. An alcoholic KOH digestion was performed on a sample size of one hundred individuals/species. From both species, a total of 564 microplastic recoveries were obtained. Of them, 62% of microplastics were found in *Megalaspis cordyla* with 6 particles per individual and 48% in *Amblygaster sirm* with 4 particles per individual. Upon examination by using a stereomicroscope, various colours and types of microplastics were identified. In torpedo scad, fibers were abundant (72.5%), followed by pellet and films of 13.97% and 13.44%, respectively. The predominant colour of the fibres was yellow (26.88%) in this species. In spotted sardines, black pellets were found to be higher (32.29%), fibres were only 26.04% (green and blue fibres), 10.41% (red fibres), followed by white film (5.20%). According to these findings, *Megalaspis cordyla* ingested twice as much microplastic as *Amblygaster sirm*. Polymers like polyvinyl ester and polystyrene were identified in this species by FTIR-ATR analysis. The findings of this research demonstrate that fish are contaminated with microplastics, and they also open up new avenues for investigation into the factors influencing the amount of microplastics and other pollutants found along Chennai's coast.

Keywords: Plastic pollution, Microplastics, fish, Chennai coast, polymers.



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INTRODUCTION

Synthetic organic polymers, such as plastic, are produced by extracting different monomers, most frequently from gas or oil. Due to their exceptional practical qualities and affordable price, plastics have evolved into an essential component of contemporary life. Plastic litter has entered the marine ecosystem as a result of extensive fishing, negligent plastic dumping, and the discharge of industrial waste into the ocean. Nowadays, plastic makes up almost 10% of the municipal garbage produced annually across the globe. Five percent or more of the plastic produced every year finds its way into the ocean, where it endures and gathers enormously [1]. It is anticipated that 350 million metric tons of plastic were produced in 2018 [2]. By 2025, there will be an order-of-magnitude increase in the amount of plastic that enters the seas compared to the 4.8–12.7 million tons that were there in 2010 [1]. Although plastic has long been recognized as the main component of marine litter, microplastics (MPs), a new kind of synthetic material, has lately come to light as a possible marine threat. On the ocean's surface, the MPs were first discovered in 1972 [3]. Plastic particles having a diameter of around 20 mm were referred to as MP when they were first described [4]. Afterward, the definition was changed to encompass any plastic particles less than 5 mm as MPs [5]. MPs are distributed globally due to their high mobility and comprehensive residence durations [6] and are predominant in marine locations, which is becoming progressively more widespread [7]. MPs build up in a variety of open and deep-water sedimentary and pelagic environments, affecting biodiversity from the equator to the Polar Regions. A combination of sea currents, waves, and wind patterns causes them to be dispersed in water columns [8–10]. The presence of MPs in marine ecosystems is currently a significant worldwide environmental concern due to the growing input of debris from many sources into the ocean [11–12].

Two groups of MPs are distinguished: Primary MPs have been engineered to be incredibly tiny (microbeads) and are either employed specifically in beauty products or as a precursor to granules. Large debris of plastic degrades and fragments physically, chemically, and biologically to produce secondary MPs [13]. These particular MPs are derived from industrial abrasives, fishing, ship disassembly, and plastic leaking from waste sites. In the maritime environment, synthetic clothing may potentially be a source of MPs [14–16]. The large surface area of MPs renders them vulnerable to the absorption of various contaminants, including organic and heavy metal pollutants [17–18], as well as the desorption of those compounds into the environment [19–20] or organisms that are a part of the food chain and ultimately enter human bodies. MPs may have more harmful effects when combined with other chemical pollutants and microorganisms [21]. As a result, microbiological infections and chemical pollutants are likely to progressively build up in the living tissues of these creatures and produce Eco toxicological consequences [22]. MPs display a diverse range of polymers with varying colours, densities, and chemical compositions [23]. They are distinguished by their capacity to last for extended periods in aquatic environments and by their capacity to be carried across long distances [24] from their source, which corresponds to the sites of human activity. Because of their small size, MPs are easily devoured by marine biota. More than 270 taxa and 330 species [25] from various trophic levels [26] have been found to have consumed debris made of plastic globally. MPs are ingested by an extensive variety of aquatic organisms with varying intake patterns. Recent years have seen several reports on the consumption of MPs by freshwater, estuarine, pelagic, and demersal species [27, 28]. MPs are directly consumed by ingestion at the lowest trophic level, while they are indirectly transferred via the food chain to higher levels [29]. Previous research has revealed that ingesting MPs can have several adverse consequences on organisms, such as growth suppression, endocrine disruption, reduced eating and/or loss of weight, toxicity to the liver, inflammation, translocation to organs, and lower reproductive efficiency [30–32]. They result in oxidative stress, which compromises immunity, lowers viability, and, in rare circumstances even results in death [33–35].

MPs in fish have been recorded in many different coastal environments; however, data for the Bay of Bengal shoreline is limited. Around 200 million people dwell in this region, which is home to one-fourth of the world's population. Fish has played an important role in regional food security, and the majority of them are either entirely or partially dependent on the bay's fisheries [36]. The specific goals of this study were to investigate the occurrence,





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abundance, and characteristics of MPs in two commercially important fishes and to find the relation between the MP uptake and fish-feeding behaviour. The data from this study will be useful for future risk assessments of MPs to Bay of Bengal fisheries and risks to human health.

MATERIAL AND METHODS

Sample Collection and Preparation

Samples were procured at the Pattinampakkam seashore fish market, which is situated along the southeast coast of the Bay of Bengal with latitude and longitude of 13.0297°N, 80.2766°E. In early mornings and late evenings, fish from the net are readily available on the scenic loop road of Pattinampakkam. Because of its proximity to the sea, people regularly witness the arrival and departure of boats. This location offers an extensive selection of fish, crab, prawn, and mollusc species. Many people arrive as early birds at this fish market to purchase fresh fish at reasonable rates right from the net. A total of 200 fish (n=100 for each species) were collected and identified as pelagic fish [37], namely *Megalaspis cordyla* (Torpedo scad) and *Amblygaster sirm* (spotted sardine) (Fig.1 a, b) After being gathered, the fish were transported to the laboratory by using an icebox. It is then frozen at -20°C and later thawed before use. Before the experiment, fishes are cleaned with distilled water to get rid of adhesions such as dirt, mucous, blood, and MPs that are externally associated. Each fish's morphometric measurements, such as its body length (cm) and weight (g), were noted, and the fish was photographed. The gastrointestinal tract (GIT) was then removed from each fish by opening it with scissors, a knife, and forceps on an aluminum tray. After that, the GIT was weighed (g) in a Petri plate. Then ten GIT were pooled together and homogenized using a motor and a pestle. To reduce the possibility of contamination, the GIT was transferred to a 250 mL glass beaker for the extraction of MPs and encased with aluminum foil.

MP Extraction

1.5 N of KOH pellets were dissolved in 95% ethanol at room temperature to prepare 1.5 N alcoholic KOH and the reaction was observed to be exothermic. The homogenized GIT is dissolved in three times of w/v of alcoholic KOH which is then maintained at 60 °C for 12-18 hrs [38]. Reagents like KOH pellets and ethanol were purchased from Himedia. Two sets of filters with mesh sizes of 1 mm (metal) and 125 µm (Whatman No. 1) were used to filter the digested organic material. After the sieve, the liquid from the backwash and filtrate were separated and sent through a vacuum filtering unit to pass through a glass MCE membrane filter (47 mm in diameter, 0.45 µm pore size; Whatman, UK). Each filter paper was put into a different glass Petri dish, sealed, covered, and allowed to air dry before being subjected to additional examination (Fig. 2). Using a stereomicroscope, MPs were visually recognized. Every particle was counted while varying the magnification between 10 and 20 times. Every fish species' MP count, colour, and shape were noted. The number of items per fish species, with respect to the weight of body and GITs, was used to compute the abundance of MPs in addition to statistical analysis of variances.

Contamination Control

To clean the surfaces, 70% ethanol was utilized. The studies were conducted while wearing nitrile gloves and a cotton lab coat. To avoid contaminating samples with plastic particles in the air, experiments were conducted in an AHC-4A1-ESCO horizontal laminar flow cabinet. The instruments and glassware, which included forceps, were cleaned using ethanol, deionized water, and dishwashing solutions. Before usage, every liquid utilized in the studies was passed via a glass MCE filter membrane (1.0 µm pore size; 47 mm in diameter, Whatman, UK). Three successive washes with filtered water were performed on all the items, such as glasses, dissection equipment, and filtration units. To account for any possible procedural contamination, a blank sample devoid of fish GIT was created using the same methodology.





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RESULTS

Characterization of Collected Species

The collected species had two different feeding habits and morphometrics (Table 1), *Megalaspis cordyla* is a carnivore that feeds on teleosts like *Stolephorus sp.*, engrulid fishes, crustaceans like *Acetes indicus* and shrimp larvae, polychaetes, coelenterates, and molluscan *lolligo* species [39]. Among the hundred fish, 30 were females and 70 were male fish. A mean length of 25 ± 1.5 cm and a weight of 110 ± 8 g were measured in the collected samples, with a GIT weight variation of 0.005 ± 0.004 g. MPs can enter the fish body in a variety of ways since this species has diverse dietary requirements. Thus, it would either directly or indirectly ingest MP by feeding on zooplankton that have eaten MPs or through the food chain [40]. While *Amblygaster sirm* is an omnivore [41] with a mean length and weight of 13 ± 2 cm, 40 ± 5 g. It was also found that 60 female fish and 40 male fish were present in the collected sample. The fish feeds on phytoplankton, algae, fish eggs, mollusc and crustacean larvae, and arthropod appendages, so the GIT weighed 0.001 ± 0.003 g [42]. Since the size range of MP particles and plankton overlaps, *Amblygaster sirm* would have erroneously consumed them.

Occurrences of MPs in Fish

Taking into account the two species, 62 out of 100 (62%) specimens of the Torpedo scad (*Megalaspis cordyla*) examined had plastic particles in their GIT, amounting to 372 isolated particles (Table 2). Each fish has a maximum of six particles discovered. Concerning spotted sardine (*Amblygaster sirm*), the findings indicate that 48 out of 100 (48%) individual fish consumed plastic debris, totalling 192 particles, with a maximum of 4 items detected in a single fish (Table 3). It was discovered that both species had consumed MPs with distinct shapes and colours with differences in accumulation levels (Fig 3. a, b). In *Megalaspis cordyla* higher percentage of occurrence of MPs was found in fibres (72.58%) with the distribution of red fibres (21.51%), yellow fibres (26.88%), blue fibres (24.19%) than in white films (13.45%) and black pellets (13.97%) (Fig.4 a, b). Whereas, in *Amblygaster sirm* the black pellets (32.29%) were found in higher proportions than red fibres (10.42%), green fibres (26.04%), blue fibres (26.04%), and white film (5.21%) (Fig.5 a, b).

Characterization of MPs

After collecting images of the MPs, the suspected particulates were analyzed using Fourier transform infrared spectroscopy with attenuated total reflectance (FTIR-ATR Model: JASCO FT/IR-4X) to determine the chemical structure of the polymers in terms of their functional groups and the bonds that connect them. Polymers were identified based on the peaks that showed up in the spectra collected between 600 and 4000 cm^{-1} . Polyvinyl ester polymers were identified in *Megalaspis cordyla*, while polystyrene polymers were detected in *Amblygaster sirm* [43, 44]. The polymer types of the separated plastic particles were characterized by the peaks that emerged in the infrared spectrum. The peaks formed (Fig.6) between 3300 and 1000 cm^{-1} , indicating, C-CH, C-C and C-O-C stretching, followed by C-H bending were characteristic of Polyvinyl esters, belonging to the thermoplastics category. The peaks that emerged between 3400 cm^{-1} and 1300 cm^{-1} (Fig.7), signifying C-C stretching and C-H bending, precisely specified the polymer polystyrene.

DISCUSSION

To reduce plastic pollution in the marine environment, it is crucial to reduce the quantity of single-use plastics and restrict the amount of plastics entering the oceans. To effectively utilize ocean resources sustainably, a new management strategy for the gathering and reusing of plastic materials is needed, especially in the basin of the Bay of Bengal to prevent the damage caused to aquatic life. Also, many reports highlight the negative impacts of MPs in the fishes which have a direct effect on human life. Further study is needed to completely comprehend the origin, distribution, and relative intake of MPs on fish populations in the Bay of Bengal. Stunted growth caused by MPs in economically significant fish lowers the fisheries sector's profit margin by reducing the seafood's market value. While fish gut MP contamination is a serious environmental issue, the major concern is that these particles may find their





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way into the fish's edible portions. There have been instances of MPs moving from the GIT to other areas in aquatic organisms like fish [45], which is significant and motivates more research.

Fish that consume MPs, however, can also ingest some potential pollutants. These pollutants could be persistent organic pollutants that adsorb to the plastic particles in the water or additives like colorants, stabilizers, flame retardants, and plasticizers. These compounds have the potential to cause toxicity to fish by percolating into their guts or by bioaccumulating via propagating up the food chain [46]. MPs impact not just the fish but also the human beings who intake fish meal as it is consumed in three different ways: as fresh flesh, as dried fish, and as processed food stored in cans or tins. When selling fish, most vendors eliminate the digestive tract beforehand; nevertheless, when selling dry fish, the fish is sun-dried from head to bottom. When selling dried fish, the majority of vendors don't remove the digestive tract. In this instance, the abundance of plastics overshadowed the edible dry fish. A study discovered MPs in the GIT of sardines (*Amblygaster sirm*), the most common type of fish used to prepare dry fish and processed meals. To keep such fish from directly entering the human body, they must be thoroughly cleaned before drying.

As canned fish products are immediately ingested by people worldwide and are not cleansed or washed before consumption, the amount of MP toxicity associated with them is higher. While canned sardines are consumed less often in India than in other nations, research has shown that MPs are predominantly present in canned sardines [47, 48]. Therefore, the primary objective of this study was to detect MPs in fish to raise awareness of the presence of plastics in fish among fish vendors and fishermen along the Tamil Nadu coast. More research and data collection is planned to examine the accumulation of MPs in various fish-based marine foods.

CONCLUSION

The majority of fish species investigated in this study were found to devour MPs, indicating that MPs are significantly distributed across the Bay of Bengal. Extensive fishing and dumping of municipal trash from neighbouring cities are likely causes of extensive contamination. Yellow fibres and black pellets make up the bulk of ingested MPs. Although MP polymer types differ, the most frequently employed varieties are polystyrene and polyvinyl esters. The synergistic hazards impacting the fish biota and ecosystems in the Bay of Bengal were visible in terms of the shape, size, colour, and morphology of MPs. Thus, from the above results, it is evident that carnivorous fish like *Megalaspis cordyla* accumulate the most MP, which takes nearly twice as long as omnivore fish, *Amblygaster sirm*. This finding implies that MP is more concentrated in large predators with diverse food preferences than in smaller predators with limited diet choices. Thus, the amount of MPs collected in the fish body is determined by its size and eating habits.

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Table 1. Morphometric Features of the Collected Species (Df 1-Dorsal Fin I, Df 2- Dorsal Fin II)

S.No	Parameters (Length-cm, Weight-g)	<i>Megalaspis cordyla</i>	<i>Amblygaster sirm</i>
1	Body weight (BW)	110±8	40±5
2	Total length (TL)	25±1.5	13±2
3	Forked length (FL)	23±1.5	12±1
4	Standard length (SL)	21±1.5	11±0.8
5	Head length (HL)	5±0.83	3±1.3
6	Dorsal fin length	3±0.5(DF1), 3.5±0.5(DF2) 3±0.5 (DF1), 3.5±0.5(DF2)	1.5±0.2
7	Dorsal fin height	7±0.5	1.5±0.2
8	Pelvic fin length	1 ±0.5	1±0.2
9	Pelvic fin height	6±0.3	1.5±0.2
10	Pectoral fin length	1±0.4	0.5±0.1
11	Pectoral fin height	3±0.5	0.8±0.3
12	Anal fin length	2.5±0.1	1.2±0.2
	Anal fin height	0.005±0.004	0.7±0.1
	Gut weight		0.001 ±0.003

Table 2. The abundance of MPs IN *Megalaspis cordyla*

Sample No (n=10)	Presence/ Absence of microplastics	Number of fibres present	Number of Red fibres	Number of blue fibres	Number of yellow fibres	Number of white films	Number of black pellets	Total polymers
1	+	33	10	13	10	08	12	53
2	-	----	----	----	----	----	----	----
3	+	44	15	12	17	12	08	64
4	-	----	----	----	----	----	----	----
5	+	46	15	18	13	10	15	71
6	+	35	8	12	15	05	05	45
7	-	----	----	----	----	----	----	----
8	+	48	12	16	20	05	06	59
9	-	----	----	----	----	----	----	----
10	+	64	20	19	25	10	06	80

Table 3. The Abundance Of MPs IN *Amblygaster sirm*.

Sample NO (n=10)	Presence/ Absence of microplastics	Total Number of fibres present	Number of Red fibres	Number of blue fibres	Number of green fibres	Number of white films	Number of black pellets	Total polymers
1	-	----	----	----	----	----	----	----
2	+	22	02	10	10	03	15	40
3	+	30	05	10	15	02	15	47
4	-	----	----	----	----	----	----	----
5	+	20	05	08	07	01	10	31
6	-	----	----	----	----	----	----	----
7	+	21	06	10	05	02	10	33
8	-	----	----	----	----	----	----	----





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9	+	27	02	12	13	02	12	41
10	-	---	---	---	---	---	---	---



Fig. 1.a) *Megalaspis cordyla*

Fig. 1.b) *Amblygaster sirm*

Fig. 1. a, b. Represent samples of pelagic fish collected for the experiment.

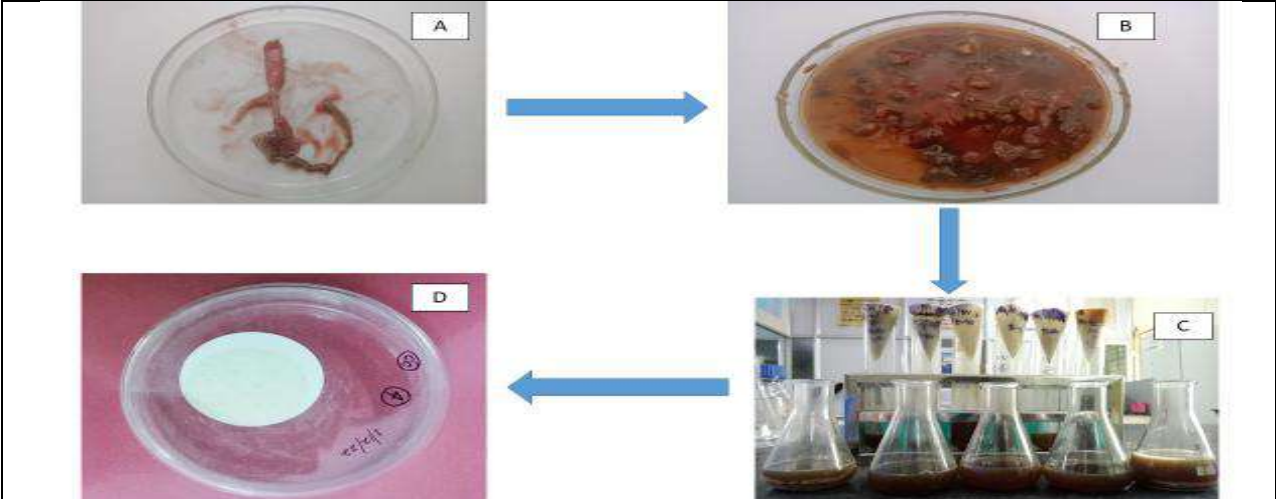


Fig.2. Stepwise procedure for MP isolation A) Dissected GIT of fish, B) Homogenised GIT with motor pestle followed by KOH digestion, C) Filtration, D) Isolated MPs in filter paper after vacuum filtration.

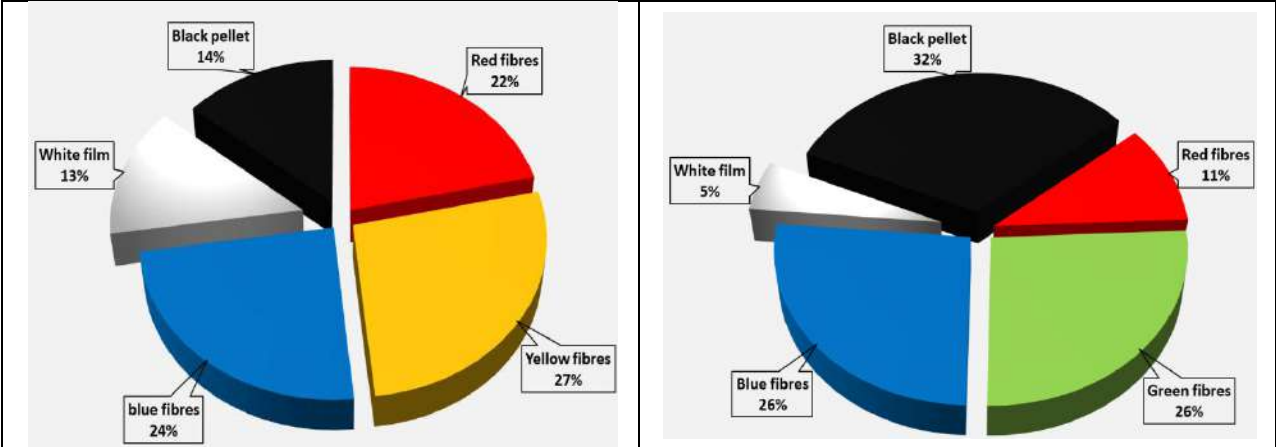


Fig. 3. a) *Megalaspis cordyla*



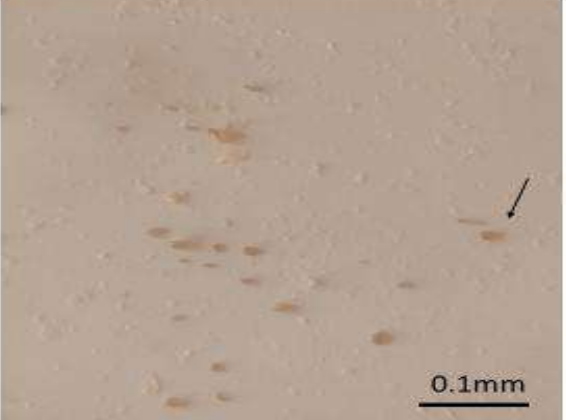
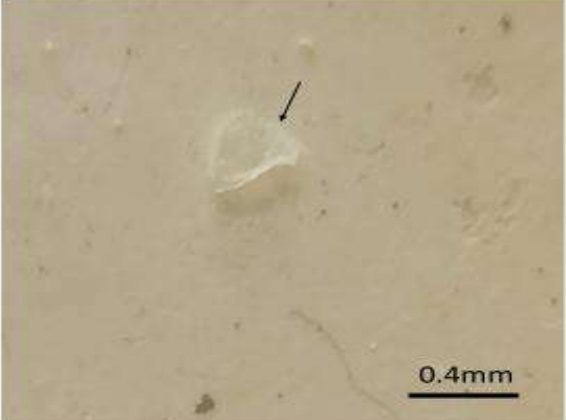
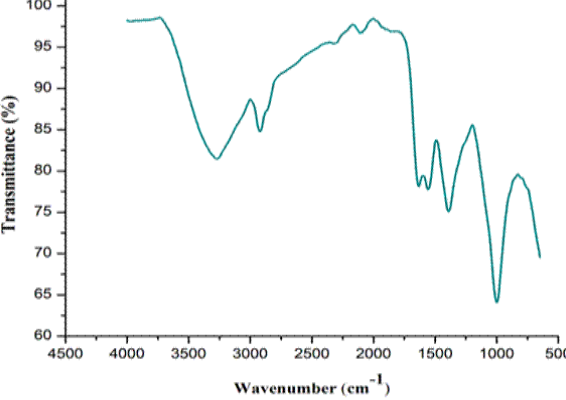
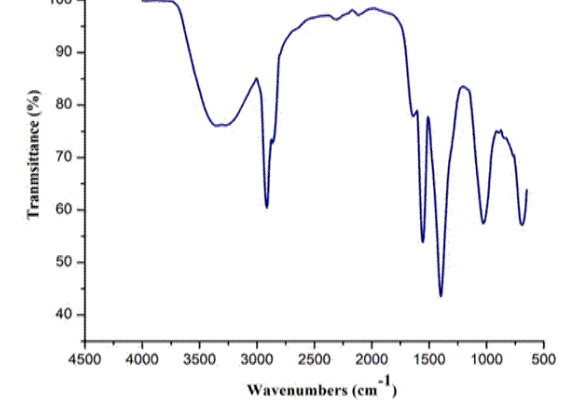
Fig.3.b) *Amblygaster sirm*

Fig.3. a) and b) Pie charts showing differences in the colour, shape, and percentage of MPs found in both species.





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Fig. 4. a)	Fig. 4. b)
Fig.4. a) Yellow and b) Red fibres isolated from the <i>Megalaspis cordyla</i> .	
	
Fig. 5. a)	Fig. 5. b)
Fig.5. a) Black pellets and b) white film collected from the <i>Amblygaster sirm.</i>	
	
<p>Fig.6. FTIR-ATR spectra displaying the polymer polyvinyl ester's characteristic peak, which is situated at 3272.97 7cm⁻¹, 1635.28 cm⁻¹, 1554.14,cm⁻¹, 1384.8 cm⁻¹, 1001.23cm⁻¹.</p>	<p>Fig.7. FTIR-ATR spectra displaying the polymer Polystyrene characteristic peak, which is situated at 3307.4 cm⁻¹, 1552.08 cm⁻¹,1398.42 cm⁻¹.</p>





RESEARCH ARTICLE

Phytoconstituents of *Adenium obesum* may exert Anti-cancer Activity by Modulating Molecular Proteins of Mitogen Activated Protein Kinase (MAPK) Pathway – An *In silico* Approach

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ABSTRACT

The Mitogen-activated protein kinase (MAPK) pathway is involved in tumor metastasis, differentiation, proliferation, apoptosis, and angiogenesis. Study shows that some of the phytoconstituents of *Adenium obesum* (AO) namely betulin, rosmarinic acid, tetrahydroxyflavone and hexahydroxyflavone had reported anti-cancer activity. We proposed that the phytoconstituents of AO may exhibit this anticancer activity by modulating the proteins of MAPK signaling pathway [Rat Sarcoma Virus (RAS), Rapidly Accelerated Fibrosarcoma (RAF), Mitogen- Activated Protein Kinase Kinase (MEK/MAPKK), Extracellular Signal-Regulated Kinase (ERK) and Nuclear Factor Kappa B (NFKB)]. Thus, the aim of this study was to determine the effect of these 4 ligands on these 5 molecular proteins of the MAPK pathway using Autodock 4.2. According to our current investigation, all 4 ligands revealed significant inhibitory activity of less than -5.67 Kcal/mol against all the 5 proteins of RAS, RAF, MEK, ERK and NFKB. This confirms the assertion that betulin, rosmarinic acid, tetrahydroxyflavone and hexahydroxyflavone can modify the MAPK pathway via modulating these proteins. However, modern *invitro* and *invivo* investigations are essential to substantiate this claim.

Keywords: MAPK, *in silico*, anti-cancer, betulin, rosmarinic acid, tetrahydroxyflavone, hexahydroxyflavone.





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INTRODUCTION

The Mitogen Activated Protein Kinase (MAPK) pathway is crucial for cellular responses involving oncogenesis, tumor progression, apoptosis, angiogenesis and drug resistance [1]. Most of the cancer pathology involves the aberration of this RAS/RAF/MEK/ERK signaling pathway genes [2]. The most prominent proteins of MAPK signaling pathway are [Rat Sarcoma Virus (RAS), Rapidly Accelerated Fibrosarcoma (RAF), Mitogen- Activated Protein Kinase Kinase (MEK/MAPKK), Extracellular Signal- Regulated Kinase (ERK) and Nuclear Factor Kappa B (NFKB)] [3] and inhibition of these proteins serve as novel therapeutic options for various cancer diseases such as lung cancer [4], melanoma [5], and pancreatic adenocarcinoma [6].

Adenium obesum (AO) is an ornamental plant with various phytoconstituents including carbohydrate, cardiac glycoside, flavonoids, terpenoids, and pregnanes [7]. This plant species exhibits various pharmacological activities such as antimicrobial, anticancer, antiviral, antioxidant, and immunomodulatory properties [8]. Traditional uses of AO include headaches, muscle and joint pain, venereal diseases, skin diseases, tooth decay, septic wounds, nasal infections, abortifacient, anti-plasmodial, anti-trypanosomal, and anti-leishmanial activity [9]. Literature evidence reveals that some of the phytoconstituents of AO namely betulin, rosmarinic acid, tetrahydroxyflavone and hexahydroxyflavone had reported anti-cancer activity [10]. We proposed that the phytoconstituents of AO may exhibit this anticancer activity by modulating these proteins of MAPK signaling pathway (RAS, RAF, MEK, ERK and NFKB). Thus, the aim of this study was to determine the effect of these 4 ligands on the molecular proteins of the MAPK pathway using Autodock 4.2.

MATERIALS AND METHODS

The PubChem database was used to download the 2D structure of 4 ligands [Betulin (Pubchem Id: 72326), Rosmarinic acid (Pubchem Id: 5281792), Tetrahydroxyflavone (Pubchem Id: 5281792) and Hexahydroxyflavone (Pubchem Id: 17918606),] and drawn in Marvin JS sketch followed by exporting as 3D structures in pdb format. The 5 molecular proteins of MAPK pathway namely RAS, RAF, MEK, ERK and NFKB were downloaded from RCSB PDB in 3D structure with their respective PDB ID. The protein ID's were RAS (3C5C), RAF (4IEA), MEK (3DV3), ERK (5MTX), and NFKB (1SVC). The heteroatoms or water molecules of these proteins were eliminated and saved in PDB format. Autodock software was used to predict the interaction of four ligands against the MAPK pathway. Proteins were prepared by adding all hydrogen atoms (polar only) to the macromolecule to correct the partial atomic charge calculation. Each atom in the molecule had its Gasteiger charges calculated. To run the Auto grid file, geometric centre of the target protein was centred on 3-D affinity grids of size 60*60*60 Å with 0.375 Å spacing. The following important docking parameters were chosen for the Lamarckian Genetic Algorithm (LGA): 150 individuals in the population, a mutation rate of 0.02, a crossing over of 0.8, 25 docking runs, and random initial positions and conformations. The 4 ligands were docked with 5 molecular protein of MAPK pathway using Auto Dock 4.2 (Version 1.5.6) software. The binding energy, inhibition constant, number of hydrogen bonds and active residues interaction were studied [11, 12].

RESULT

Our research on molecular docking studies involved 4 ligands from AO plant species namely betulin, rosmarinic acid, tetrahydroxyflavone and hexahydroxyflavone which exhibited significant binding energy for all the 5 proteins [Table 1] of RAS (-7.59 kcal/mol, -5.67 kcal/mol, -6.79 kcal / mol and -6.79 kcal /mol), RAF (-6.42 kcal/mol, -6.20 kcal/mol, -7.38 kcal/mol and -7.67 kcal/mol), MEK (-7.93 kcal / mol, -9.29 kcal/mol, -9.02 kcal/mol and -9.32 kcal / mol), ERK (-9.16 kcal / mol, -10.26 kcal/mol, -8.3 kcal/mol and -9.09 kcal / mol) and NFKB (-6.26 kcal/mol, -7.46 kcal/mol, -7.77 kcal/mol and -8.4 kcal/mol) respectively (fig 1- 20) and nearly 1 -6 hydrogen bonds were formed .The



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lower binding energy (-10.26 kcal/mol) was for rosmarinic acid with ERK by forming 4 hydrogen bonds with an inhibition constants of 30nM.

DISCUSSION

Using betulin, the RAS (3C5C), RAF (4IEA), MEK (3DV3), ERK (5MTX), and NFKB (1SVC) docking [table 1] formed nearly 1-2 hydrogen bonds with an acceptable inhibition constant, and the binding energy ranged between -6.26 and -9.16 kcal/mol (figure 1-6). Betulin, a triterpenoid, has been shown to have significant cytotoxicity against various cancers and human cell lines [13, 14]. Literature review confirms its anticancer activity is exerted by its indole nucleus through various mechanisms, including apoptosis, cell mitosis, cell signal transduction, replication and transcription, and epigenetic modification [15, 16]. Previous study shows that the presence of three functional groups, namely the secondary hydroxyl group at C-3 and the primary hydroxyl group at C-28, may be the reason for its anticancer property which may extend to its inhibitory action on RAS/RAF/MEK/ERK/NFKB pathway [17].

The docking [table 1] of rosmarinic acid with RAS (3C5C), RAF (4IEA), MEK (3DV3), ERK (5MTX), and NFKB (1SVC) demonstrated a significant binding energy in the range of -6.20 kcal/mol to -10.26 kcal/mol with 1-6 hydrogen bonds and a good inhibition constant (Figure 6-10). Rosmarinic acid, a flavonoid, has antioxidant, anti-inflammatory, immune-modulatory, neuroprotective and anticancer properties [18]. It has anti-neoplastic effects on leukemia, hepatocellular carcinoma, gastric carcinoma, colorectal cancer, breast cancer, and small cell lung carcinoma [19]. Literature review reveals that the structure of rosmarinic acid is composed of a hydrophobic group and a phenolic hydroxyl group and the presence of carboxylic acid at the C-9' position in the hydrophobic group inhibits the proliferation of cells [20] and may account for its *in-silico* modulation of the 5 molecular proteins of MAPK pathway.

The docking [table 1] of tetrahydroxyflavone revealed that 1-3 hydrogen bonds with an appropriate inhibition constant were formed by RAS (3C5C), RAF (4IEA), MEK (3DV3), ERK (5MTX), and NFKB (1SVC) with excellent binding energies in the range of -6.79 kcal/mol to -9.02 kcal/mol (Figure 11-15). Tetrahydroxyflavone, a flavonoid, has various health benefits, including anti-hypertension, anti-inflammatory, anti-allergy, and anti-cancer activities. It may also help to prevent the various types of cancer such as breast, cervical, ovarian, bladder, prostate, colon, pancreatic, gastric, oesophageal, oral, and skin, liver, lung, and kidney cancers [21]. The structure of tetrahydroxyflavone contains A, B rings, has benzene nucleus and C ring that contains oxygen and two to three carbon double bonds along with hydroxyl groups at locations C5, C7, C3', and C4'. These hydroxyl moieties and their two to three double bonds confers the anti-inflammatory, antioxidant, and anti-cancer properties [22] hence contributing to this inhibitory property on RAS/RAF/MEK/ERK/NFKB pathway.

The docking [table 1] of RAS (3C5C), RAF (4IEA), MEK (3DV3), ERK (5MTX), and NFKB (1SVC) that included hexahydroxyflavone had favourable interactions, exhibiting binding energies between -6.79 and -9.32 kcal/mol and the formation of 2-6 hydrogen bonds (Figure 15-20). Hexahydroxyflavone has been shown to alleviate symptoms associated with cancer, inflammatory, and diabetic diseases [23]. It is an isoflavonoid and the presence of hydroxyl groups at R3, R6, and R7 positions is crucial for its anti-cancer activity [24] thus adding to its MAPK pathway proteins modulation. To our knowledge this is the current study to establish the inhibitory property of these three flavonoids and one triterpenoid of AO with the 5 MAPK pathway proteins. Some intact studies have reported anti-RAS, anti-RAF, anti-MEK, anti-ERK, and anti-NFKB only for some of these flavonoids and triterpenoid [25, 26, 27, 28]. RAF inhibitors such as Sorafenib, vemurafenib, and dabrafenib, MEK inhibitors namely selumetinib and trametinib and ERK suppressors ulixertinib have been studied extensively to be effective in treatment of various types of cancers [1]. Therefore, further insight aspect of these bioactive molecules will help to address these intricate details of the cancer pathophysiology. Hence our *in-silico* molecular docking studies of betulin, rosmarinic acid, tetrahydroxyflavone and hexahydroxyflavone establishes that these 4 ligands exert their anticancer activity by modulating all the 5 predominant proteins (RAS, RAF, MEK, ERK and NFKB) of the MAPK pathway.





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CONCLUSION

Our current study highlights that the fact of 4 ligands from *Adenium obesum* exerts its anticancer action by modulating the RAS/RAF/MEK/ERK/NFKB pathway proteins of MAPK.

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Nil

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Table 1: Docking score of AO phytoconstituents with various molecular proteins of MAPK pathway using Autodock 4.2

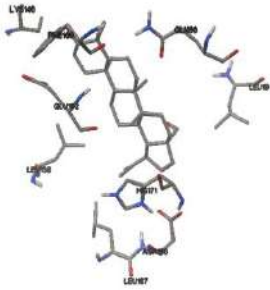
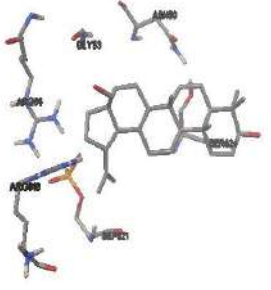
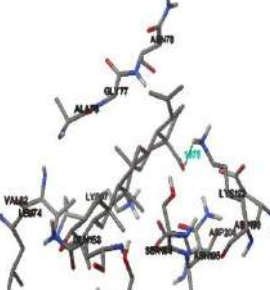
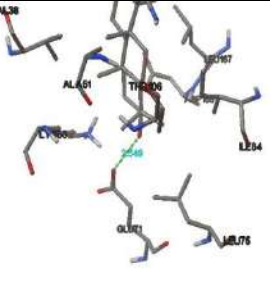
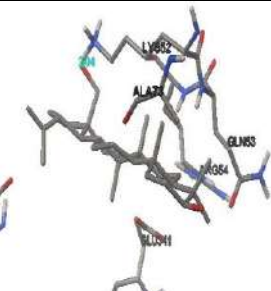
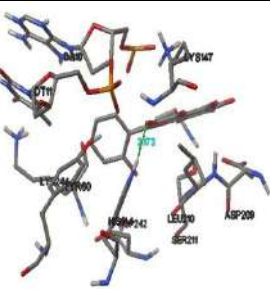
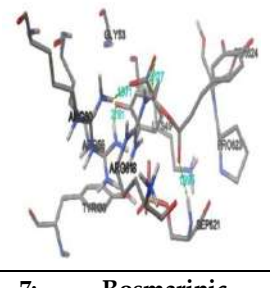
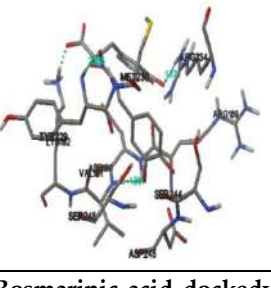
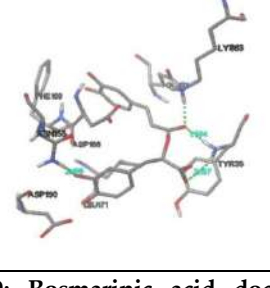
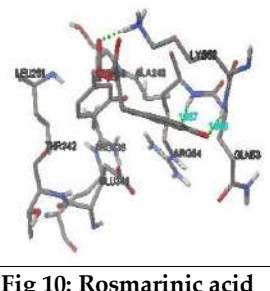
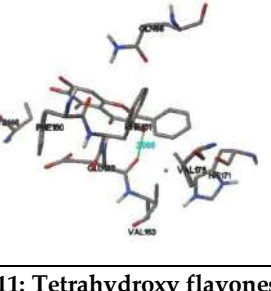
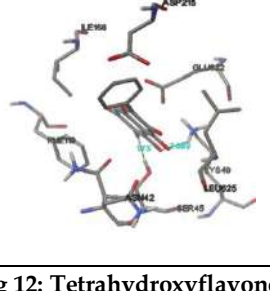
Proteins	Ligands	Binding energy (kcal/mol)	Inhibition constant (nM)	Hydrogen bond
RAS	Betulin	-7.59	272	0
RAF		-6.42	1965	0
MEK		-7.93	153	2
ERK		-9.16	193.42	1
NFKB		-6.26	2595	1
RAS	Rosmarinic acid	-5.67	7011	1
RAF		-6.20	2832	5
MEK		-9.29	155.72	6
ERK		-10.26	30	4
NFKB		-7.46	337	3
RAS	Tetrahydroxyflavone	-6.79	1046	1
RAF		-7.38	393	3
MEK		-9.02	244.35	2
ERK		-8.30	827.21	3
NFKB		-7.77	203	1
RAS	Hexahydroxyflavone	-6.79	1053	2





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RAF	-7.67	238	6
MEK	-9.32	146.7	1
ERK	-9.09	218.23	4
NFKB	-8.40	691.28	2

		
Fig 1: Betulin docked with RAS	Fig 2: Betulin docked with RAF	Fig 3: Betulin docked with MEK
		
Fig 4: Betulin docked with ERK	Fig 5: Betulin docked with NFKB	Fig 6: Rosmarinic acid docked with RAS
		
Fig 7: Rosmarinic acid dockedWithRAF	Fig 8: Rosmarinic acid dockedwith MEK	Fig 9: Rosmarinic acid docked withERK
		
Fig 10: Rosmarinic acid dockedwithNFKB	Fig 11: Tetrahydroxy flavones docked with RAS	Fig 12: Tetrahydroxyflavone docked with RAF





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<p>Fig 13: Tetrahydroxyflavone docked with MEK</p>	<p>Fig 14: Tetrahydroxyflavone docked with ERK</p>	<p>Fig 15: Tetrahydroxyflavone docked with NFKB</p>
<p>Fig 16: Hexahydroxyflavone docked with RAS</p>	<p>Fig 17: Hexahydroxyflavone docked with RAF</p>	<p>Fig 18: Hexahydroxyflavone docked with MEK</p>
<p>Fig 19: Hexahydroxyflavone docked with ERK</p>	<p>Fig 20: Hexahydroxyflavone docked with NFKB</p>	





Radiopharmaceuticals: Key Concepts and Practical Considerations

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ABSTRACT

Radiopharmaceuticals are the molecules which are labeled by the radionuclides. These radioactive molecules can be employed for diagnosis and progressively more, for the treatment of various ailments. Nevertheless, the radiation received by your body is very low and regarded as safe when used in small amounts. When these drugs are administered in large doses to treat illnesses, the body may react differently. In this article, we have focussed on the history of radiopharmaceuticals, their clinical significance, quality control, handling and safety precautions. The transformation of radionuclei has been explored herein.

Keywords: Radionuclides, Clinical significance, Quality control, Transformation, Precautions

INTRODUCTION

Radiopharmaceuticals are the molecules labeled by the radionuclides. They are biologically active compounds that provide a beneficial source of energy. Radiopharmaceuticals are compounds that are used for diagnostic therapy and imaging purposes [1,2]. Radiotracer was first used as a diagnostic procedure by Blumgart and Weiss. They used radium C (consequently identified as ²¹⁴Bi) to assess the arm-to-arm transit time of blood [1,3]. The invention of Tc-99m described by Perrier and Segre [4]. de Hevesy and Chiewitz examined the metabolism and distribution of molecules labelled with ³²P at Biels Bohr's Institute, Copenhagen [5]. In the beginning, I-131 became an important





agent for the treatment of benign and malignant tumors. In the 1980s and 1990s, Somatostatin receptor-targeted therapies were developed. With the introduction of two agents, the radiolabelled antibodies were developed in 2002-2003. FDA recognised the Radium-223 dichloride which was used for management of castrate-resistant metastatic prostate cancer in 2013 [1].

History

Radiopharmaceuticals had their origin in the 1920s to 1930s [1]. Radiopharmaceutical therapy began in 1941 with the efforts of Saul Mertz and Arthur Robert. In the 1970s, the radiopharmaceuticals have been involved innovation in adaption as well as chemistry to regulation. That year the US-FDA (United States-Food and Drug Administration) announced the regulation of radiopharmaceuticals as drugs and withdraw the exemptions granted to them. From the chemistry viewpoint, the 1970s encompass the main advancements in employment of Tl^{201} for imaging of myocardial perfusion and metastatic bone disease Sr^{89} was used. This decade was likely to be remembered by introducing the Tc^{99m} chemistry and F^{18} -FDG, The Eckelman and Richards acquaint the Tc^{99m} -diethylenetriaminepentaacetic acid for use in renal imaging. In the 1980s, the ^{99m}Tc grew further. In 1985 Ell and research group reported the use of ^{99m}Tc -exametazime for imaging of cerebral blood flow which was amended by Amersham [6]. In 1988, the FDA approved this for stroke diagnosis [1]. In this decade, the ^{131}I -meta-iodobenzylguanidine was employed for the management as well as detection of malignant pheochromocytomas, neuroblastomas and myocardial imaging [1,7,8]. The 1980s was called an active decade for PET research. The first imaging neuroreceptors were reported by Henry Wagner. He imaged the dopamine receptors using 9-N- ^{11}C -methylspiperone with his co-workers [9]. As first example, SPECT neuroreceptor imaging was carried out by using ^{123}I -3-quinuclidinyl-4-iodobenzilate in Alzheimer's disease to image muscarinic acetylcholine receptors [10].

In the 1990s, the first myocardial agent to receive FDA approval was ^{99m}Tc -sestamibi. The ^{99m}Tc -sestamibi is even now extensively employed for imaging of myocardial infarction. It was used in radio-guided surgery to identify parathyroid adenomas and breast cancer imaging as well [11]. The US FDA approval of ^{18}F -FDG was also a significant factor in the decagon's significance for PET imaging [1]. In the 2000s, the hybrid PET/CT scanners were developed. good manufacturing practise regulations for radiopharmaceuticals were implemented at the same time [12]. In 2004, the Klunk published the first human study on the use of C11-Pittsburgh compound B for amyloid plaque imaging using dementia patients [13]. Radiation therapy has become more prevalent in clinical care in this decade. Zevalin (ibritumomab tuuxetan), a monoclonal antibody used in radioimmunotherapy for low-grade or relapsed B-cell non-Hodgkin's lymphoma, was approved by the FDA. Bexxar, an unlabeled tositumomab, and ^{131}I -labeled tositumomab, a combination utilised by Glaxo Smith Kline, were also authorised for the treatment of non-Hodgkin lymphoma that had relapsed or was resistant to chemotherapy and rituxan[1].

In the 2010s, the radiopharmaceuticals research matured from research techniques to powerful standards. The FDA approved ^{123}I - DaTscan (^{123}I -ioflupane[GE Healthcare]) in 2011 after it was under development from 1990s years. It was used for differentiating the tremor due to Parkinson's disease [1,14]. Also, N13-ammonia (myocardial perfusion imaging), F^{18} -NaF (imaging of bones) and F^{18} -FDG (cardiology, oncology and neurology) were approved by FDA in this decade [1]. To assess the density of β -amyloid neuritic plaque in adult patients with cognitive impairment undergoing estimation for Alzheimer's disease using PET imaging. Amyvid (florbetapir), Vizamyl (flutemetanol) and Neuraceq (florbetaben) were all approved by FDA in the year 2012, 2013 and 2014, respectively. In the year 2013 for castration-resistant prostate cancer management, Bayer got FDA approval for Xofigi ($^{223}RaCl_2$) [1]. Pharmaceutical drugs which contain radioactive isotopes are groups of medicinal radio compounds called radiopharmaceuticals. They can be used as therapeutic and diagnostic agents. Contrast media are different from radiopharmaceuticals because radiopharmaceuticals are compounds that emit radiation and contrast media do not. They include the group of radioactive compounds or agents which are used for diagnostic as well as therapeutic agents. Radiopharmaceuticals alter or absorb ultrasound and electromagnetic waves. The radiopharmaceuticals must administer systemically as they localize to particular tissue owing to their bimolecular features. Bimolecular properties include hyper-intensity in PET (Positron Emission Technology) which indicates the high tissue metabolic demand. The storage of radiopharmaceuticals is difficult as they actively emit radiation [15].



Sakshi Jangra *et al.*,**Clinical Significance of Radiopharmaceuticals**

For healthcare, radiopharmaceuticals are essential. These are radioactively labelled molecules that are biologically active and serve as a useful source of ionising radiation. Numerous cancers as well as benign tumours have been treated with them [15–17]. Designing of radiopharmaceuticals is complicated and rigorous. Because each nuclide has a half-life and a decay mode, choosing the right nuclide is essential. It also includes the factors like molecular stability, ease, and production cost [18,19]. The route of administration is mainly by IV or oral [20].

Radiopharmacology

It is the study of radiopharmaceuticals in the branch of pharmacology. Studying the chemical characteristics of radiotracers and how they interact with living things is the main driving force behind radiopharmacology. To advance or broaden this field, the International Association of Radiopharmacology was founded. This organization's mission is to bring together all those with an interest in national and international organizations employing radiotracers in the biological sciences and medicine. [21]. The commonly used radioisotope is Technetium-99m (Tc-99m) as it emitted gamma rays and also has many useful properties [21].

Radio-Pharmacy

Radio-pharmacy encompasses the studies associated to the aspect of biological, biochemical, chemical, pharmaceutical and physical radiopharmaceuticals. It contains an understanding related to the quality control, preparation and design of radiopharmaceuticals. It covers how the physiochemical and biological characteristics of radiopharmaceuticals relate to one another. Concerns about managing, choosing, storing, dispensing, and using radiopharmaceuticals correctly were limited. The radio-pharmacy is designated at an area where access is very much controlled. The properly trained staff should get permitted, essentiality regarding the strict adherence to work procedures. The figure 1 indicated three fundamental parameters that affect staff doses in the radio-pharmacy [22].

Characteristics of Radiopharmaceuticals

A diagnostic purpose is served by almost 95% of radiopharmaceuticals. The remaining 5% are employed for therapy purposes. The pharmacologic effects of these are negligible as they were used in tracer quantities. As they differ significantly from conventional drugs using no dose-response. The one of inherent characteristics of radiopharmaceuticals are that the patients receive an unavoidable radiation dose always [23,24].

Major components of radiopharmaceuticals are:

1. A radionuclide that provides the desired radiation characteristics.
2. A compound with chemical properties that determines the behavior of radiopharmaceuticals regarding their physiological and distributional behaviour [23,24].

Quality Control of Radiopharmaceuticals

- It is necessary to perform the radiochemical and radionuclidic purity tests.
- Methods must be effective and very fast because of very short half life of some radiopharmaceuticals.
- Not all quality control examinations have been done, but a number of radiopharmaceuticals (having very short half-lives) might need to be used and distributed after batch certification is evaluated [25].

Radionuclides

Radionuclides are elements in radioactive form. While some are intentionally created by humans or result from nuclear reactions, others are found naturally in the environment. Each radionuclide releases radiation at a unique rate that is expressed in terms of half-life. [26,27]. The half-life of the radioactive compound is defined as the time required by the atoms present in the radioactive compound to decay. A radioisotope decays radioactively when it changes into a different radioisotope, producing radiation in the process. The half-lives of all radionuclides vary according to the decay time, which can range from a few short seconds to a million years. This process could take very long period or be quick, depends on the radionuclide. Half-life of radioactive molecules can vary from milliseconds to days, hours, and occasionally million years [28,29]. In figure 2, indicated the twelve radionuclides encountered in commercial, military and medical activities [30–32].



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In terms of radiation protection, radon (mainly ^{222}Rn) and its decay products are naturally occurring radionuclides that should be particularly avoided. Given that they account for nearly half of the total effective dose equivalent obtained from anthropogenic and natural radioactivity, they are the most significant sources of radiation exposure for the general public. The decay products of radon give progeny from inhalation. They get deposited in the epithelium of the bronchi and respiratory tract [33]. A EURATOM Drinking Water Directive states that the radon content of drinking water should be evaluated. Safe Drinking Water Act is required for radon analysis. As the reports of the US EPA specify the detectable concentration of ^{226}Ra and ^{228}Ra is 0.037 Bq/L. The decay chain of U^{238} includes the important natural radionuclides called ^{210}Po and ^{210}Pb because of the exposure to radiation through inhalation and ingestion [33]. Radionuclides used in nuclear medicine have extremely brief half-lives. Similar to technetium-99m, which is frequently utilised in medical imaging studies, this isotope also has a six-hour half-life. The patient can maintain a low dose with the aid of this half-life. After a day, the procedure's radioactivity will drop by more than 90% [33]. Uranium is the long-lived radionuclide. In the Earth's crust, naturally occurring uranium-238 has a half-life of roughly 4.5 billion years. For instance, we can detect uranium atoms from the time the earth formed if we take a sample of soil from anywhere in the world. [33,34].

Transformation of Radionuclides

The transformation of radionuclides includes the series before reaching the stable state. Let's take the example of Uranium-238 and in this process, several types of radionuclides formed. We refer to this as a decay chain. There are multiple isotopes produced by the decay of uranium-238 as represented in figure 3 [35–37].

Applications of Radiopharmaceuticals

Table 1 and Table 2 indicated the specific nuclear medicines and role of radiopharmaceuticals in various branches, respectively.

Safety Precautions and Handling of Radionuclides

The term "radiation safety" refers to ideas, specifications, methods, and procedures pertaining to shielding individuals from the destructive effects of ionising radiation [44]. The safety precautions are enlisted in the table 3. After reading thoroughly about radiopharmaceuticals or radionuclides the one question put up in mind. Are radiopharmaceuticals safe?

- Absolutely, Like any medicine.
- Out of a million injections, there is a chance of two to three reactions, with more than half resulting in rashes.
- Immediately tell the doctor about any allergic reactions or unusual feelings after the administration of the radiopharmaceutical product.
- It is not advised for pregnant women to take radiopharmaceuticals in order to protect the foetus from radiation.
- For a while after taking it, you might need to give up breastfeeding.
- During the diagnosis of children, a very small amount of radiopharmaceuticals is used [22]

CONCLUSION

Radionuclides are used in a wide range of nuclear energy-related fields. Globally, the significance and utilisation of radionuclides in medicine for both diagnosis and treatment are constantly growing. Ionising radiation is essential for modern medicine. Technologies such as gamma knives, linear accelerators, brachytherapy, nuclear medicine (both therapeutic and diagnostic), computed tomography scans, and X-ray imaging are just a handful that have transformed medical diagnosis and treatment. This review article presents to the country a plan for regulating all forms of ionising radiation used in medicine that will ensure maximum public access to the advantages of ionising radiation's complete spectrum of medicinal applications while also providing sufficient health and safety protection for the general population. Our goal is to promote and encourage basic research and applied technology in the radiopharmaceutical sciences, and to provide a forum for discussion and information dissemination in this field. We should be deeply committed to this mission. It is a very fulfilling and exciting time to work in the field of





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radiopharmaceutical sciences because of all the advancements. As such, we look forward to the new developments that occur in the next decades.

Conflict Of Interest

Authors would hereby like to declare that there is no conflict of interests that could arise.

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Table 1 Specific nuclear medicine radiopharmaceuticals [38]

Sr. No.	Radio-isotopes	Name	Examination	Administration Route	In vivo / In vitro	Non Imaging (NI) / Imaging (I)	Half-Life
1.	Calcium-47	Ca-47-Ca ²⁺	Metabolism of bone	I.V.	In vitro	NI	4.7 days
2.	Carbon-11	C11-L-methyl-methionine	Imaging of brain tumor and parathyroid	I.V.	In vivo	I	20.38 minutes
3.	Carbon-14	C14-PABA (para-amino benzoic acid)	Pancreatic cancer	Per-oral	In vitro	NI	5730 years
4.	Chromium-51	Cr51-[heart scan/blood volume]	Scanning of red cell volume heart; gastrointestinal blood loss; sites of sequestration	I.V.	In vitro	NI	27.7 days
5.	Cobalt-57 Cobalt-58	C057-Balman	Absorption in GIT	Per-oral	In vitro	NI	272 days 71 days
6.	Erbium-169	Er169-Colloid	Arthritic ailments	Intra-articular	-	-	9.38 days
7.	Fluorine-18	F18-FDG	Imaging of tumor and myocardia	I.V.	In vivo	I	1.83 hrs
8.	Fluorine-18	F18-Sodium Fluoride	Imaging of bone	I.V.	In vivo	I	-
9.	Fluorine-18	F18-Desmethoxyfallypride	Imaging of dopamine receptors	I.V.	In vivo	I	-
10.	Fluorine-18	F18-Fluorocholine	Imaging of prostate tumor	I.V.	In vivo	I	-
11.	Gallium-67	Ga67-Ga ³⁺	Imaging of tumor	I.V.	In vivo	I	78.3 hrs
12.	Gallium-67	Ga67-Ga ³⁺	Imaging of inflammation /	I.V.	In vivo	I	





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			Infection				
13.	Gallium-68	Ga68-Dotato or DOTATATE	Imaging of neuroendocrine tumor	I.V.	<i>In vivo</i>	I	68 minutes
14.	Gallium-68	Ga68-PSMA	Imaging of prostate cancer	I.V.	<i>In vivo</i>	I	-
15.	Hydrogen-3	H3-water	Total body water	Per-oral or I.V.	<i>In vivo</i>	NI	12.4 years
16.	Indium-111	In111-DTPA	Laveen shunt (Ventriculoperitoneal shunt)	I.P.	<i>In vivo</i>	I	2.8 days
17.	Iodine-123	I123-Iodide	Imaging of thyroid and its metastases	Per-oral or I.V.	<i>In vivo</i>	I	13.2 hrs
18.	Iodine-125	I125-fibrogen	Imaging of clot	I.V.	<i>In vivo</i>	I	60 days
19.	Iodine-131	I131-MIBG	Imaging of neuroectodermal tumor	I.V.	<i>In vivo</i>	I	8days
20.	Lutetium-177	¹⁷⁷ Lu-DOTA-TATE	Tumors of Gastroenteropancreatic neuroendocrine	I.V.	<i>In vivo</i>	I	6.647 days
21.	Technetium-99m	Tc-99m	Diagnostic Imaging	I.V. or Per-oral	<i>In vitro</i>	I	6 hrs

Table 2 Role of radiopharmaceuticals in various branches

Sr. No.	Applications	Uses	References
1.	Diagnostic purpose	In order to be used for diagnostics, radiation must be strong enough to travel through bodily tissues and reach the body being detected.	[39]
2.	Radiotherapy	Radioisotopes are employed for therapeutic efficacy. Radioisotopes work on the basis of destroying diseased tissue without harming healthy tissue. Because beta radiation can penetrate sufficiently, it can be used to treat eye surface lesions. Deeply seated tumours can be treated with gama radiation due to its strong penetrating power.	[40]
3.	Sterilization	Used in the radiation sterilisation of heat-sensitive medications, such as vitamins, hormones, antibiotics, surgical dressings, and single-use syringes.	[41]
4.	For research	In order to identify the reaction's mechanism, they are employed in biochemical research.	[42,43]

Table 3. [45–47] The safety precautions are enlisted

Sr. No.	Safety precautions
1.	To decrease the probability of unnecessary exposure of radiation, the GPR should be strictly followed.
2.	The area where the radioactive work is being done needs to be marked, and it needs to be periodically checked.
3.	All radiation workers must put on suitable protective clothing, surgical gloves and radiation monitoring devices.
4.	When not in use, the radionuclides need to be stored in sealed containers.



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5.	To prevent contamination and exposure hazards the area of the department surveyed regularly.
6.	Work surfaces ought to be covered with stainless steel, glass, or plastic.
7.	Use a tray lined with absorbent paper to collect spills and stop contamination from spreading.
8.	Avoid using a mouthpipette when pipetting.
11.	Hands should be thoroughly cleaned.
12.	Forceps or another appropriate tool should always be used when handling radioactive materials instead of your hands.
13.	When radionuclides are stored in unsealed containers, do not consume food, beverages, or smoke.
14.	To protect both public and employees, the radiation survey metre should be used.
15.	The recommended action levels for a wipe test are 0.25 mR/hr (milli Roentgens) in unrestricted areas and 20 mR/hr in restricted areas.

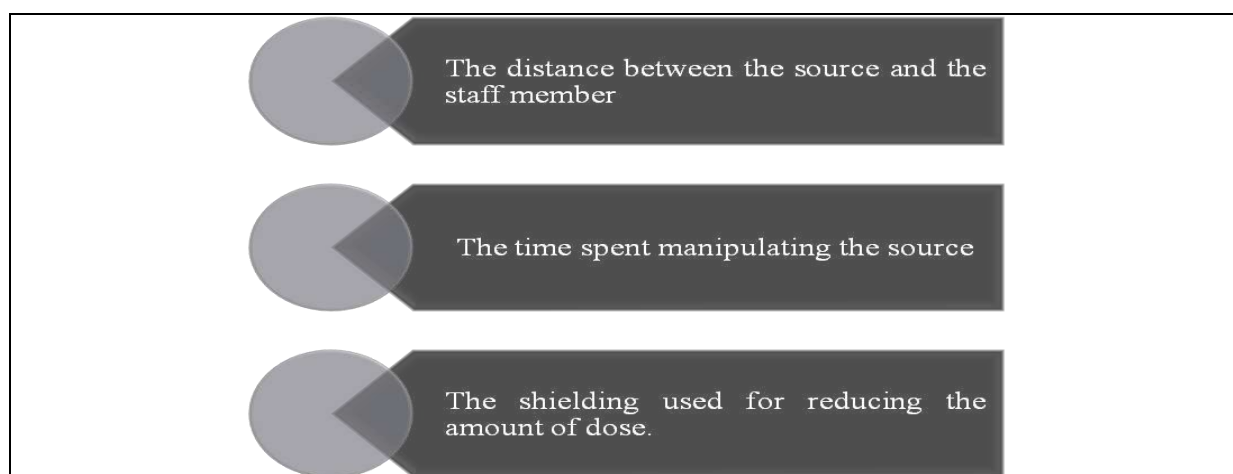


Figure 1 Fundamental parameters affect staff doses in the radio-pharmacy.

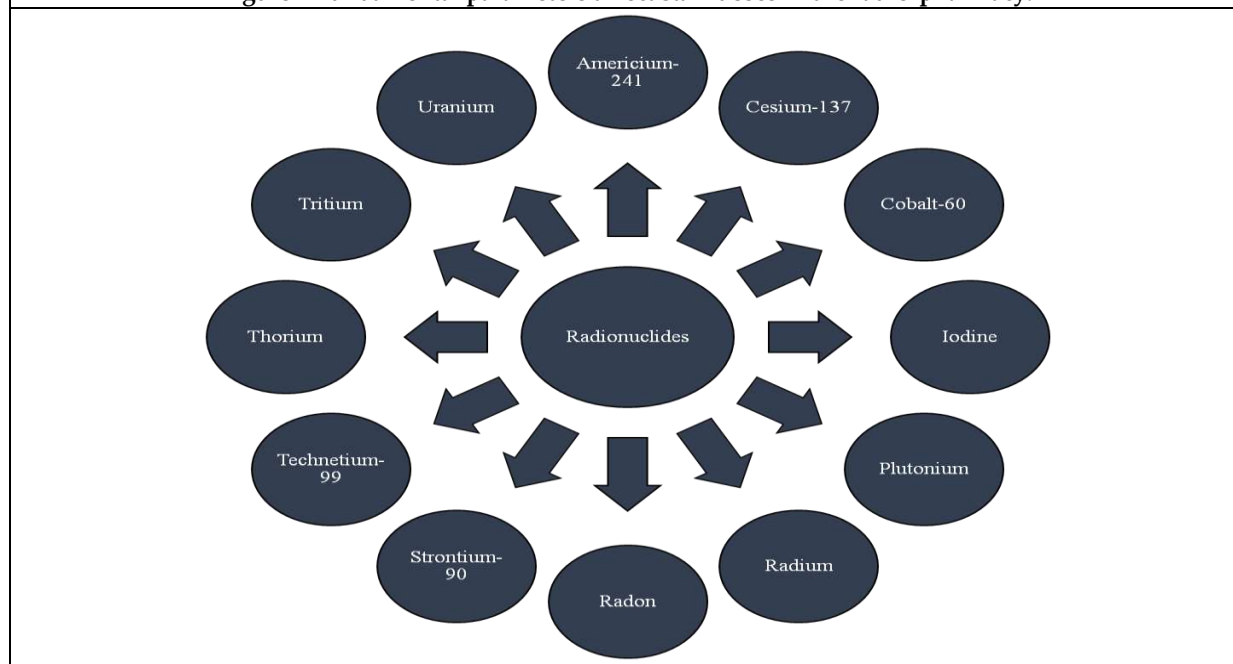
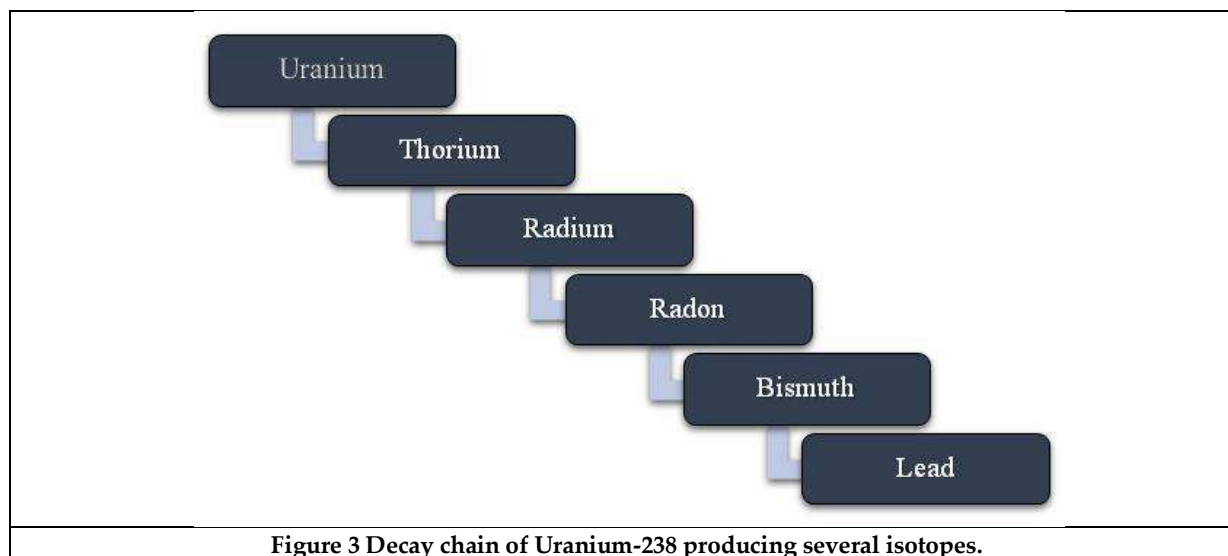


Figure 2 Important radionuclides encountered in medical, commercial, and military activities.





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Socio Economic Analysis of Tuberose Growers in Thiruvannamalai District of Tamil Nadu

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ABSTRACT

Tuberose is a native of Mexico from where it spread to the different parts of the world during 16th century. Tuberose is cultivated in large scale in France, South Africa, North Carolina, USA and in many tropical and subtropical areas including India. In India, the commercial cultivation of tuberose is done mainly in Mysore, Devanhalli taluk (Karnataka), East Godavari, Guntur, Chittoor, Krishna, Distt. (Andhra Pradesh), Thiruvannamalai, Dindigul and Madurai (Tamil Nadu), Pune, Thane, Sangli (Maharashtra), Bagnen, Kolaghat, Midnapore, Panskura, Ranaghat, Krishnanagar (West Bengal). At present the total area under tuberose cultivation in the country is estimated to be about 3,000 hectare (2020-21). Tuberose is one of the major flower crops in Tamil Nadu, growing in almost all the districts except Nilgris and Ramanadhapuram. From the table 1, it would be seen that Thiruvannamalai district was a leading district with an area of 977 ha followed by Madurai (283 ha) and Dindigul (188 ha) in the year 2020-2021. Tamil Nadu is one of the leading states in loose flowers as well as in tuberose production. Among the 38 districts of Tamil Nadu, Thiruvannamalai district is the major producer of tuberose and it stood first in area under tuberose). Hence, Thiruvannamalai district was selected for this study. The Specific Objectives of the Study Undertaken are, to study the socio economic level of tuberose growers in the study area. A **two** stage **random** sampling method was adopted to select the sample farms. The study concluded that the share of middle aged group was larger followed by old aged and young aged group. The majority of sample farmers had medium experience and the farmers with long rich experience were found lower. Among the tuberose growers, the percentage of secondary education was predominant in the study area. The cropping pattern of the sample farmers is tuberose occupied the highest proportion of the cropped area with 26.86 per cent to the total cropped area followed by Rice, Marigold, Sugarcane and others. The overall study concluded that the production of tuberose is profitable in the study region.

Keywords: Tuberose, Socio Economic Analysis, Tuberose Growers, Loose Flowers, Production.





INTRODUCTION

Tuberose is a native of Mexico from where it spread to the different parts of the world during 16th century. They are used for making artistic garlands, floral ornaments, bouquets and buttonholes. The long flower spikes are excellent as cut flowers for table decoration. The flowers emit a delightful fragrance and are the source of tuberose oil which is used in high value perfumes and cosmetic products. Furthermore, fragrant flowers are added along with stimulants or sedatives to the favorite beverage prepared from chocolate and served either cold or hot as desired. The bulbs are reported to contain an alkaloid lycorine, which causes vomiting. The bulbs are rubbed with turmeric and butter and applied as a paste over red pimples of infants. Dried tuberose bulbs in the powdered form are used as a remedy for gonorrhea. In Java, the flowers are eaten along with the juices of the vegetables. Tuberose is cultivated in large scale in France, South Africa, North Carolina, USA and in many tropical and subtropical areas including India. In India, the commercial cultivation of tuberose is done mainly in Mysore, Devanahalli taluk (Karnataka), East Godavari, Guntur, Chittoor, Krishna, Distt. (Andhra Pradesh), Thiruvannamalai, Dindigul and Madurai (Tamil Nadu), Pune, Thane, Sangli (Maharashtra), Bagnen, Kolaghat, Midnapore, Panskura, Ranaghat, Krsishnanagar (West Bengal). At present the total area under tuberose cultivation in the country is estimated to be about 3,000 hectare (2020-21).

Tuberose Cultivation in Tamil Nadu

Tuberose is one of the major flower crops in Tamil Nadu, growing in almost all the districts except Nilgris and Ramanadhapuram. From the table 1, it would be seen that Thiruvannamalai district was a leading district with an area of 977 ha followed by Madurai (283 ha) and Dindigul (188 ha) in the year 2020-2021. As tuberose is cultivated through bulbs, periodical irrigation and intervals are necessary for proper flowering. Because of its essentiality, most of the tuberose cultivation taken place only by irrigation. In Tamil Nadu, out of 2314 ha of total area 99.61 percent of the area were irrigated. In Thiruvannamalai district, in all the blocks, tube rose cultivation taken place only by irrigation.

Tuberose Cultivation in Thiruvannamalai District

It would be seen from the table 2, among the 18 blocks of Thiruvannamalai district tuberose cultivated in all the blocks except Jamunamarathur and Vembakkam blocks. Tuberose cultivated area was highest in Pudupalayam block, (381 ha) followed by Chengam (210 ha) and Thiruvannamalai block (110 ha).

Objectives of the Study

To study the socio economic level of tuberose growers in Thiruvannamalai District of Tamil Nadu.

METHODOLOGY

Choice of the Study Area

Tamil Nadu is one of the leading states in loose flowers as well as in tuberose production. Among the 31 districts of Tamil Nadu, Thiruvannamalai district is the major producer of tuberose and it stood first in area under tuberose). Hence, Thiruvannamalai district was selected for this study.

Sampling Procedure

Pudupalayam block in Thiruvannamalai district was purposively selected since the proportion of area under tuberose in this block was found to the highest among all the **blocks** present in Thiruvannamalai district. Moreover, the wholesale flower market for entire Thiruvannamalai district is located at Thiruvannamalai town is nearer to Pudupalayam block would also justify the choice of Pudupalayam block as the study area. **Pudupalayam block consists of 43 revenue villages.** A **two stage random** sampling method was adopted to select the sample farms. At **first stage**, all the **revenue villages** in **Pudupalayam block** were arranged **in** assenting **order** based on **the** proportion of area under tuberose to gross cropped area in the year (2020-2021) and four **revenue** villages were selected at random. At second stage, all the farmers in the each of the selected revenue villages were arranged in the assenting



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order based on the proportion of tuberose area to the total cropped area in their farm and 30 farmers were selected at random from each of the selected four revenue villages, thus **constituting a total sample** size of 120 farmers.

Tools of Analysis

Conventional Analysis

Simple averages and percentages were employed to study the socio economic variables such as age, education, size of family, size of operational holding, irrigation sources, cropping pattern, inputs used and yield of different cut flower crops.

RESULTS AND DISCUSSION

General Characteristics of Sample Farmers

Before proceeding to objective-wise analysis, the general characteristics like age wise distribution of sample farmers, farming experience of sample farmers, size of farm holdings, land holding pattern, consumption pattern of farm families, size and composition of farm family, level of literacy, composition of farm assets, non-farm assets, credit availability and cropping pattern were presented to gain better perspectives.

Age Wise Distribution of Sample Farmers

The age wise analysis indicated that 85.00 percent of the tuberose growers were middle aged falling in the age group between 30 and 55 years, followed by old aged farmers falling in the age group of above 55 years (8.33 percent) and young aged tuberose growers falling below the age of 30 years, constituting 6.67 percent of the total number of tuberose growers. The results indicated that the share of middle aged group was high followed by old aged group and young aged group.

Farming Experience of the Sample Farmers

From the table 4, it could be inferred that 60 percent of the sample farmers had an experience of 10 to 20 years in tuberose cultivation, while 33.33 percent of the farmers had an experience of less than 10 years. The farmers with rich experience of more than 20 years were less and constituting only 6.67 percent of the total tube rose growers. From the above results it could be concluded that majority of sample farmers had medium experience and the farmers with long rich experience was found less in the study area.

Educational Status

The level of literacy influences the level of adoption of new technologies in the farm. It could be observed from Table 5, that the proportion of farmers with secondary education was found high with 51.66 percent, followed by farmers with collegiate education (23.33 percent) and primary education (20.83 percent). Illiterate farmers accounted for 4.16 percent and it was evident that secondary education was dominant among the tuberose growers.

Size and Composition of Farm Families

From the above table 6 shows that, the proportion of adult males to the total family size was about 44.66 percent in sample farm. The share of adult female to the total family size was 41.02 percent, while the children constituted about 14.32 percent. Earners constituted 53.88 percent and dependents accountants for the rest 46.12 percent. The results revealed that adult males found more in sample farm families.

Size of Farm Holdings

It could be seen from the above table 7, that the average size of the farm was 1.13 ha. Garden land constituted 68.15 percent and wet land constituted 31.85 percent of the average of the sample farm. Dry land was not found in the sample farms and it was inferred that among the sample farms possessed only garden land.



**Radhakrishnan et al.,****Land Holding Pattern**

From the above table 8, it was indicated that most of the farmers were owners and owned lands in the sample farms constituted 62.94 percent of the total operated area. The area leased in was about 37.06 percent and there is no leased out land in sample farms.

Pattern of Investment on Farm Assets

Investment on assets is necessary for farm production. Investment made on fixed productive assets such as land, irrigation structure, livestock and headstock influence farm production, borrowing, repayment and also the adoption of modern technologies. The value of farm assets indicates the economic soundness and liquidity of farm business. The composition of farm assets in investment of sample farms is presented in table 9.

Land was the major asset in sample farms with a share of 84.23 percent to total investment. The investment on livestock followed the land asset with a share of 7.07 percent to the total investment. The dead stock and buildings and irrigation structures constituted 5.70 and 3.00 percent to total investment in the sample farms respectively.

Investment on Non- farm Assets

It could be observed from table 10, that bank deposits were the major non-farm investment with a share of 32.23 percent to the total non-farm investment in the sample farms. The investment on insurance was the next best asset after bank deposits (29.00 percent), jewellery (26.00 percent) and followed by postal savings (5.82 percent). Other household investment had the least share with 6.95 percent to the total non- farm investment.

Annual Income of Sample Farmers

It could be observed from the table 11, that most of the farmers earning less than Rs.2.Lakhs as annual (53.33 percent). Only 10 percent of the farmers were earning more than Rs.5.Lakhs as annual income in the study area while 36.67 percent of the farmers were earning with an annual income of Rs.2 to 5 lakhs.

Cropping Pattern of Sample Farmers

It could be observed from the table 12, that tuberose occupied the highest proportion of the cropped area with 26.86 percent to the total cropped area in the sample farms followed by rice, marigold, sugarcane, groundnut, black gram with a proportion of 18.67, 14.21, 13.69, 12.68, 15.68 percent respectively and the crops which occupied the lowest proportion of the cropped area and the crops were Tapioca (4.65) and Ragi (7.55).

Age Wise Distribution of Tuberose Gardens in the Sample Farms

It was observed that tuberose crop raised from the bulbs come to commercial bearing from the 4th months, through first year. The yield increases in 2nd year and it can be maintained up to 3 years under good management, after that, the yield considerably decreases and it was not economically viable. It could be observed from the table 13, that the number of tuberose farms less than 1 to 2 years constituted 50.00 percent of the total farms` and covering 45.75 percent of the total area. Also the observations of the survey revealed that majority of tuberose sample farms were in commercial bearing stage and output could be enhanced by proper application of recommended level of inputs.

CONCLUSIONS

The study concluded that the share of middle aged group was larger followed by old aged and young aged group. The majority of sample farmers had medium experience and the farmers with long rich experience were found lower. Among the tuberose growers, the percentage of secondary education was predominant in the study area. Dry land was not found in the sample farms and it was inferred that among the sample farms possessed only garden land. For the annual income, most of the farmers were earning less than Rs 2 lakhs (53.33 per cent), 10 per cent of the farmers was more than Rs.5 lakhs and 36.67 per cent of the farmers were earning of Rs. 2 to 5 lakhs in the study area. The cropping pattern of the sample farmers is tuberose occupied the highest proportion of the cropped area with 26.86 per cent to the total cropped area followed by Rice, Marigold, Sugarcane and others. In case of the age wise





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distribution of tuberose gardens, the observations of the survey revealed that majority of tuberose sample farms were commercial bearing stage and output could be enhanced by proper application of recommended level of inputs. The overall study concluded that the production of tuberose is profitable in the study region.

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Table 1- District Wise Area under Tuberose in Tamil Nadu

Si. No.	District	Irrigated	Un Irrigated	Total
1	Ariyalur	5	0	5
2	Coimbatore	22	0	22
3	Cuddalore	1	0	1
4	Dharmapuri	68	4	72
5	Dindigul	185	0	188
6	Erode	105	1	106
7	Kancheepuram	33	0	33
8	Kanyakumari	25	0	25
9	Karur	21	0	21
10	Krishnagiri	46	1	47
11	Madurai	281	2	283
12	Nagapattinam	2	0	0
13	Namakkal	15	0	15
14	Perambalur	38	2	40
15	Pudukkottai	55	0	55
16	Ramanadhapuram	0	0	0
17	Salem	53	0	53
18	Sivagangai	12	0	12
19	Thanjavur	2	0	2
20	The Nilgris	0	0	0
21	Theni	31	0	31
22	Thirupur	9	0	9
23	Thiruvallur	111	0	111
24	Thiruvannamalai	977	0	977
25	Thiruvarur	2	0	0
26	Thoothukudi	23	0	23
27	Tirchy	49	0	49
28	Tirunelveli	80	0	80
29	Vellore	30	0	30
30	Villupuram	14	0	14
31	Virudhunagar	6	0	6
	State Total	2,305	9	2,314

Source: Season and Crop Report Tamil Nadu (2020-21) Department of Economics and Statistics Chennai- 600 006

Table 2- Block Wise Area under Tuberose in Thiruvannamalai District

Si. No.	Name of the Blocks	Area (ha)
1	Pudupalayam	381
2	Chengam	210
3	Thiruvannamalai	110
4	Kalasapakkam	109
5	Thurinjapuram	87
6	Thandarampattu	22
7	Kilpennathur	20
8	West Arani	11



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9	Arani	8
10	Polur	5
11	Thellar	4
12	Vandavasi	3
13	Peranamallur	2
14	Cheyyar	2
15	Anakavur	2
16	Chepet	1
17	Jamunamarathur	0
18	Vembakkam	0

Source: Deputy Director of Horticulture, Thiruvannamalai (2020-2021).

Table 3- Distribution of Sample Farmers Based on Age

Si. No	Age particulars (in years)	Number	Percentage to total
1	Below 30 years	08	6.67
2	Between 30-55 years	102	85.00
3	Above 55 years	10	8.33
	Total	120	100.00

Table 4- Farming Experience of the Sample Farmers

Si. No:	Farming experience	Number	Percentage to total
1	Below 10 years	40	33.33
2	Between 10-20 years	72	60.00
3	Above 20 years	08	6.67
	Total	120	100.00

Table 5- Educational Status of the Sample Farmers

Si. No	Particulars	Number	Percentage to total
1	Illiterates	05	4.16
2	Primary education (between 1-5 th std)	25	20.83
3	Secondary education (between 6-12 th std)	62	51.66
4	Collegiate (above 12 th std)	28	23.33
	Total	120	100.00

Table 6- Size and Composition of Farm Families

Si. No	Particulars	Numbers	Percentage to total
1	Adult male	1.84	44.66
2	Adult female	1.69	41.02
3	Children	0.59	14.32
4	Average size of the family	4.12	100.00
5	Earners	2.22	53.88
6	Dependents	1.90	46.12
	Total	4.12	100.00





Table 7- Size of Farm Holdings (per farm)

Si. No	Type of land	Area in ha	Percentage to total
1	Wet land	0.36	31.85
2	Garden land	0.77	68.15
3	Dry land	0.00	0.00
	Total	1.13	100.00

Table 8- Tenure Wise Distribution of Operational Area in the Sample Farms (in ha)

Si. No	Particulars	Sample farm	Percentage to Total
1	Area owned	102.80	62.94
2	Area leased in	60.54	37.06
3	Area leased out	0.00	0.00
	Total	163.34	100.00

Table 9- Average Investment on Farm Assets (Rs./Farm)

Si. No	Particulars	Sample farm	Percentage to total
1	Land	6,22,480.80	84.23
2	Buildings and irrigation structure	22,125.50	3.00
3	Dead stock	42,134.20	5.70
4	Live stock	52,265.50	7.07
	Total investment	7,39,006.00	100.00

Table 10- Average Value of Non-farm Investment/ Farm Household (Rs./Farm)

Si. No	Particulars	Sample farm	Percentage to total
1	Bank deposits	1,22,508.33	32.23
2	Value of jewellery	98,799.70	26.00
3	Postal savings	22,122.17	5.82
4	Insurance	1,10,203.23	29.00
5	Other household investments	26,435.67	6.95
	Total	3,80,069.10	100.00

Table 11- Annual income of Sample Farmers (Rs.in Lakhs/Farm)

Si. No	Annual income	Numbers	Percentage to all
1	Below 2 lakhs	64	53.33
2	2-5 lakhs	44	36.67
3	More than 5 lakhs	12	10.00
	Total	120	100.00

Table 12- Cropping Pattern of Sample Farmers

Si. No	Particulars	Sample farm (in ha)	Percentage to total
1	Rice	25.50	18.67
2	Sugarcane	18.70	13.69
3	Groundnut	17.31	12.68
4	Marigold	19.40	14.21
5	Tuberose	36.68	26.86
6	Ragi	10.31	7.55
7	Tapioca	6.35	4.65
8	Blackgram	2.30	15.68
	Total	136.55	100.00



**Radhakrishnan et al.,****Table 13- Age Wise Distribution of Tuberose Gardens in the Sample Farms**

Si. No	Age of the Tuberose crop	Number of Farms	Percentage to total no of sample farms	Area under Tuberose by sample farmers (in ha)	Percentage of area to total sample tuberose farms area
1	Up to 1 Year	32	26.67	38.50	28.20
2	1 to 2 Years	60	50.00	62.48	45.75
3	2 to 3 Years	28	23.33	35.57	26.05
	Total	120	100.00	136.55	100.00





The Correlation between Sleep Deprivation and Depression among College Students

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ABSTRACT

This research study aims to find out the quality of Sleep deprivation and depression among college students. It is a quantitative research study. The study was conducted using a self-administered questionnaire that was distributed to a random sample of college students from different universities. The questionnaire included questions about sleep quality, duration, and patterns, as well as questions about depression symptoms. The data was analyzed using correlation coefficients to determine any relationship between the two variables. The results of the study showed that there was a low positive correlation between sleep deprivation and depression among college students. This means that as sleep deprivation increases, the likelihood of experiencing depression symptoms also increases, but the correlation between the two is not strong enough to conclusively say that one causes the other. The study also found that a majority of college students reported poor sleep quality and insufficient sleep duration. This suggests that college students are at a higher risk of experiencing depression due to sleep-related issues. The study has important implications for college campuses and mental health programs. Campus health services should focus on promoting good sleep hygiene and providing resources for students to improve their sleep quality and duration. Information about the study- This study provides valuable information about the link between sleep deprivation and depression among college students. While the relationship between the two is not strong enough to make definitive conclusions, campus health services and mental health programs should prioritize addressing sleep quality and duration to improve overall mental health outcomes for college students. Overall, this research study adds to the growing body of literature on the relationship between sleep deprivation and depression and helps to raise awareness



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about the importance of promoting good sleep quality and mental health among college students. By improving sleep quality, it may be possible to reduce the risk of depression among college students. Additionally, mental health programs should address the link between sleep and depression and provide resources for students struggling with sleep-related mental health issues.

Keywords: Sleep deprivation, sleep quality, Depression, Mental health, College students

INTRODUCTION

In our fast-paced, modern society, where demands and responsibilities seem to be ever increasing, sleep deprivation has become a prevalent and concerning issue. Simultaneously, mental health conditions, particularly depression, have emerged as major public health challenges affecting millions of individuals worldwide. The link between sleep and mental wellbeing has long been recognized, but recent research has shed new light on the intricate relationship between sleep deprivation and depression. This report aims to explore and analyze the existing body of scientific literature to unravel the correlation between sleep deprivation and depression, highlighting the implications for both individuals and society as a whole. Sleep is an essential physiological process that facilitates restoration, consolidation of memories, emotional regulation, and overall cognitive functioning. Conversely, chronic sleep deprivation, characterized by insufficient quantity or poor quality of sleep, can have detrimental effects on physical, mental, and emotional health. It is estimated that approximately one-third of the global population experiences inadequate sleep, with prevalence rates even higher among individuals with mental health disorders.

Depression, a pervasive mood disorder, affects more than 300 million people worldwide, making it the leading cause of disability globally. While several factors contribute to the development and persistence of depression, emerging evidence suggests a bidirectional relationship between sleep and depression. Sleep disturbances, such as difficulty falling asleep, frequent awakenings during the night, and early morning awakenings, are commonly observed symptoms in individuals diagnosed with depression. Furthermore, research indicates that individuals with chronic sleep problems are at a significantly higher risk of developing depressive symptoms over time. This report will delve into the various mechanisms underlying the sleep-depression connection, including disrupted neurochemical processes, alterations in brain structure and function, and dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis. Additionally, it will explore the impact of sleep deprivation on cognitive processes, emotion regulation, and the overall wellbeing of individuals, both in the short term and over extended periods. Understanding the correlation between sleep deprivation and depression has significant implications for public health, clinical practice, and policy-making. Effective interventions targeting sleep disturbances may serve as preventive measures, attenuating the risk of depression and enhancing overall mental well-being. Conversely, treating underlying depressive symptoms could potentially alleviate sleep disturbances, improving sleep quality and duration. Moreover, identifying the intricate relationship between sleep and depression opens doors for innovative therapeutic approaches that simultaneously address both conditions. By synthesizing the current literature and analyzing empirical studies, this report aims to provide a comprehensive understanding of the correlation between sleep deprivation and depression. The findings within this report will contribute to a deeper comprehension of the sleep-depression connection, facilitating the development of evidence-based strategies to promote healthy sleep habits and prevent or alleviate depression. Ultimately, this knowledge can positively impact the lives of individuals affected by these conditions and enhance the well-being of society as a whole.

The main purpose of this study —The Correlation Between Sleep Deprivation and Depression Among College Students was to explore the correlation between sleep deprivation and depression among college students by using a survey questionnaire to collect data. The survey will cover various factors such as the number of hours students sleep per night, their sleep quality, their level of stress, and their mental health. The study will also examine the impact of academic workload, social life, and other factors that may affect students' sleep and mood. The findings



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from this study can provide insights the relationship between sleep deprivation and depression among college students. It can help to identify the risk factors for depression and sleep disorders among students, as well as the potential strategies that can help to prevent and manage these conditions. The study may also contribute to the development of effective prevention and intervention programs that can improve students' mental health and well-being. Moreover, the results of this study can be used to generate further research in this area and to increase awareness of the importance of sleep and mental health among college students. In conclusion, this study is significant as it sheds light on the correlation between sleep deprivation and depression among college students. It aims to provide valuable insights into the factors that contribute to sleep disorders and depression among students and to identify effective strategies for prevention and management. Ultimately, this study can contribute towards improving the overall health and well-being of college students.

Significance of the Study

The study on the correlation between sleep and depression is to make people understand that lack of good quality sleep can worsen their depression symptoms and make it even more difficult to manage the condition. Additionally, sleep disturbances can increase the risk of developing depression, especially in individuals who have a family history of the condition. Evidence also suggests that treating sleep disorders can help improve depression symptoms. Therefore, it's important to address sleep disturbances as part of a comprehensive depression treatment plan. This may include improving sleep hygiene practices, such as maintaining a consistent sleep schedule, avoiding caffeine and alcohol before bedtime, and creating a relaxing sleep environment. For some individuals, medication or therapy may be necessary to address sleep issues and improve depression symptoms. Overall, the study on the correlation between sleep and depression highlights the importance of prioritizing sleep as an essential component of mental health. By proactively managing sleep issues, individuals can improve their overall wellbeing and potentially prevent or alleviate symptoms of depression have significant insomnia, which is difficulty falling or staying asleep, while 40% may experience hypersomnia or excessive sleepiness. Additionally, obstructive sleep apnea, a condition in which a person's breathing is repeatedly interrupted during sleep, is also more common in individuals with depression. The link between poor sleep and depression is bidirectional. Depression can disrupt the body's natural sleep-wake cycle, making it difficult to fall asleep or stay asleep. This can lead to fatigue, difficulty concentrating, and low energy levels. The resulting tiredness can also make it harder to engage in activities that can help to improve mood, such as exercise, socializing, and pursuing hobbies. This can then perpetuate negative feelings and increase the risk of developing further depression. On the other hand, long-term sleep deprivation or poor sleep quality can increase the risk of developing depression. Sleep is important for regulating mood and emotions, and when we don't get enough sleep, it can disrupt this balance. Lack of sleep can also affect levels of neurotransmitters such as dopamine, serotonin, and norepinephrine, which play key roles in mood regulation. Fortunately, interventions that improve sleep quality can also help to reduce symptoms of depression. Cognitive behavioural therapy for insomnia (CBT-i) is one such intervention that has been shown to be effective in treating both insomnia and depression. Other strategies to improve sleep hygiene and sleep quality, such as regular exercise, reducing caffeine and alcohol consumption, and sticking to a regular sleep schedule, may also be helpful.

The study also highlights the importance of proper sleep hygiene and getting enough restful sleep. This includes sticking to a regular sleep schedule, avoiding caffeine and alcohol before bed, creating a relaxing sleep environment, and finding ways to manage stress and anxiety. By addressing sleep problems and making efforts to improve sleep quality, individuals with depression may be able to alleviate some of their symptoms and improve their overall quality of life. Sleep is an essential component of good health and well-being, and it's crucial to prioritize it as part of a holistic approach to managing depression. Moreover, it's essential to seek professional help if you're struggling with sleep disturbances or depression symptoms. Mental health professionals can provide valuable guidance and support to help you manage these conditions and improve your sleep quality. In conclusion, the study on the correlation between sleep and depression underscores the importance of prioritizing good quality sleep for individuals with depression. By addressing sleep disturbances and practicing good sleep hygiene, individuals with depression may be able to alleviate some of their symptoms and improve their overall well-being.



**Manjusha Deka Saikia and Tsuthunglo Khuvung****Objectives**

- To find out the sleep quality of students
- To study the effect of sleep deprivation and depression on students.
- To find the correlation between sleep and depression

Hypothesis

- There will be significant difference between sleep deprivation and depression with respect to gender
- There will be correlation between sleep deprivation and depression among college students

Research Questions

The study aimed answer specific questions

- What is the quality of sleep among students?
- Does sleep affect depression?
- How is sleep related to depression?

REVIEW OF LITERATURE

Anyansi Lombardero, Caira D Hansen, Andrew E Richie, Duncan G Campbell and Aaron W Joyce in 2019 conducted research on —Insufficient Sleep, Insomnia, and Health Correlates in American Indian/Alaska Native Populations. The study found that AI/AN populations have a higher prevalence of insufficient sleep and insomnia compared to the general U.S. population, which may be due to cultural, environmental, and socio-economic factors. In addition, the study identified several health correlates associated with insufficient sleep and insomnia, including higher rates of obesity, diabetes, cardiovascular disease, depression, and anxiety among AI/AN individuals who report poor sleep quality. The study also highlighted the need for culturally appropriate interventions to improve sleep health among AI/AN populations. These interventions may include education and awareness campaigns, traditional medicine and healing practices, and adaptations of evidence-based interventions to align with cultural norms and values. Overall, this study provides important insights into the prevalence and health correlates of insufficient sleep and insomnia in AI/AN populations and highlights the need for targeted interventions to improve sleep health and reduce the burden of chronic disease in these communities.

Fefie Wang, Eva Biro in 2020 —Determinants of sleep quality in college students. The study found that academic workload, stress, and electronic device usage before bedtime were the three main determinants of poor sleep quality in college students. Academic workload was identified as a significant risk factor for poor sleep quality since it can lead to anxiety, rumination, and racing thoughts, which can impede falling asleep and maintaining sleep. Moreover, stress was found to have a significant impact on sleep quality, as the higher the perceived stress levels, the poorer the sleep quality. Finally, electronic device usage before bedtime was also found to be a significant determinant of poor sleep quality, as it can disrupt the circadian rhythm and delay the onset of sleep. The study suggests that interventions to improve sleep quality in college students should target these three main determinants. For example, reducing academic workload and implementing stress reduction programs can help alleviate the negative effects of academic stress on sleep quality. Implementing technology-free hours before bedtime and promoting healthy sleep hygiene practices can also help reduce the negative effects of electronic device usage on sleep quality. Overall, understanding the determinants of poor sleep quality in college students is essential for developing effective interventions to improve their sleep and overall well-being.

David Nutt, Sue Wilson, Louise Paterson in 2008 —sleep disorders are core symptoms of depression. The study found out that the experience of sleep disturbances in depression, there are also objective measures that suggest changes in sleep architecture, such as reduced slow wave sleep and rapid eye movement sleep abnormalities. These changes may be related to alterations in neurotransmitter systems, such as serotonin and noradrenaline, which are



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also implicated in the pathophysiology of depression. Furthermore, the bidirectional relationship between sleep and depression is complex. Sleep disturbances can contribute to the onset, exacerbation, and maintenance of depression. On the other hand, depression can also lead to changes in sleep patterns. For example, depression can cause early morning awakening, difficulty falling asleep, and restless, fragmented sleep. Overall, the study highlights the significant impact that sleep disturbances have on depression and emphasizes the importance of addressing sleep disturbances as part of depression treatment. Effective treatments for depression, such as antidepressant medication and psychotherapy, can improve sleep disturbances. Additionally, sleep-specific treatments, such as cognitive-behavioural therapy for insomnia, can also be effective in treating both sleep disturbances and depression.

Sahil Bajaj, Karina S Blair, Amanda Schwartz, Matthew Dobbertin R James, R Blair in 2020 —Worry and insomnia as risk factors for depression during initial stages of COVID-19 pandemic in India|| the outcomes during a pandemic requires identification of risk factors that are specifically related to this situation. The study aimed to investigate the role of worry and insomnia as risk factors for developing depression during the initial stages of the COVID-19 pandemic in India. The study recruited 511 participants from different parts of India through an online survey. Participants were asked to complete measures of worry, insomnia, depression, and demographic characteristics such as age, gender, education, and marital status. The data was collected during the first few weeks of the pandemic lockdown in India. The study found that worry and insomnia were significant risk factors for developing depression during the initial stages of the pandemic. Participants who reported higher levels of worry and insomnia had greater odds of experiencing depressive symptoms. Additionally, females and those who were unmarried were also at increased risk of developing depression. The study highlights the importance of identifying specific risk factors that are related to pandemic situations when predicting mental health outcomes. In this case, worry and insomnia appear to be important factors that should be addressed when implementing mental health interventions during a pandemic. Overall, the study suggests that interventions targeting worry and insomnia could be effective in preventing or managing depression during the COVID-19 pandemic and similar situations in the future.

Sandeep Grover, Alaknanda Dutt, and Ajit Avasthi in 2010 —An overview of Indian research in depression||. This study has also focused on the cultural and social determinants of depression in the Indian context. One of the key findings of Indian research on depression is the high prevalence rate of the disorder in the country. A study conducted by the National Mental Health Survey of India in 2016 reported the lifetime prevalence of depression to be 10.9%. It also found that depression was more common in females, those living in urban areas, and those with lower educational and socioeconomic status. Indian research has also highlighted potential psychosocial risk factors for depression, such as life events, social support, and stigma. Studies have also examined the role of neurotransmitters, such as serotonin and norepinephrine, in the development and treatment of depression. Additionally, comorbidities, such as anxiety disorders and substance abuse, are also commonly studied in relation to depression. Assessment and diagnosis of depression is another area of focus in Indian research. Studies have examined the reliability and validity of various assessment tools, such as the Hamilton Rating Scale for Depression and the Patient Health Questionnaire-9. The cultural validity of diagnostic criteria, such as the Diagnostic and Statistical Manual of Mental Disorders (DSM), has also been studied. Finally, Indian research has examined various treatment options for depression, including psychotherapy, pharmacotherapy, and alternative treatments such as yoga and mindfulness meditation. Research on culturally appropriate interventions for depression have also been conducted, particularly for individuals who may not have access to traditional mental health services or who prefer non-pharmacological treatments. Overall, Indian research on depression has contributed significantly to the understanding of the disorder, its prevalence, risk factors, and effective treatments. The cultural sensitivity of research in the Indian context is also noteworthy, as it has highlighted the unique cultural and social determinants of depression and has paved the way for culturally appropriate interventions.

Joao Dinnies and Miguel Bragania in 2018 —Quality of Sleep and Depression in College Students||. The study found that there is a significant association between poor quality of sleep and depression in college students. This is consistent with other research that has shown that poor sleep quality is a risk factor for the development of depression. The study looked at 171 college students from a Brazilian university and used a combination of self-



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report questionnaires, the Pittsburgh Sleep Quality Index (PSQI), and the Beck Depression Inventory (BDI). The results showed that 59% of the participants had poor sleep quality and 43% of the participants exhibited depressive symptoms. Moreover, there was a significant correlation between the PSQI scores and BDI scores, indicating that poor quality of sleep was associated with higher levels of depression. The researchers suggest that promoting healthy sleep habits among university students should be a priority in campus health interventions. This can include educating students on the importance of sleep hygiene, implementing sleep-friendly policies such as quiet hours in dormitories, and providing resources such as counselling services for those struggling with sleep-related problems and mental health issues. Overall, the study highlights the need for universities to pay attention to the mental health of their students and recognize the impact that poor sleep quality can have on their well-being.

Peggy R. Books, Alicia A Girgenti and Maura J Mills in 2009 —Sleep patterns and symptoms of depression in college students|| this study is based on a survey assessing sleep patterns and symptoms of depression. The results showed that students with more severe symptoms of depression reported significantly more difficulties falling asleep, staying asleep, and experiencing daytime sleepiness. In addition, students with depression symptoms also reported higher levels of snoring, restless sleep, and nightmares. These findings suggest that college students with symptoms of depression may be at increased risk for sleep disturbances, which could exacerbate their depressive symptoms and decrease their overall well-being. The study recommends that healthcare providers working with college students should recognize the connection between sleep and depression and consider addressing sleep disturbances as part of a comprehensive treatment plan for depression. Additionally, the study suggests that colleges and universities may benefit from implementing policies and programs to promote healthy sleep habits among their student populations. Overall, the study highlights the importance of addressing sleep in the prevention and management of depression among college students.

Zheng, J Yang, Ye, Chen, Zhang, Xiao in 2015 —A systematic review of studies on the prevalence of Insomnia in university students|| where this study published on a particular topic and synthesize the evidence to formulate conclusions. The researchers searched multiple databases and found 33 relevant studies that met their inclusion criteria. The studies included over 50,000 university students from different countries and cultures. The prevalence of insomnia among university students was found to range from 4.4% to 74.4%. The pooled prevalence across all studies was 36.4%. The factors associated with insomnia in university students included psychological distress, academic stress, poor sleep habits, and unhealthy lifestyle choices. The authors concluded that insomnia represents a significant health concern for university students and highlights the need for interventions to promote healthy sleep hygiene and manage stress. This systematic review provides valuable insights into the prevalence and correlates of insomnia among university students, which can inform the development of targeted interventions to promote sleep health in this population.

Mateusz Babicki , Partyk Piotrowski, Agnieszkei Mastalerz-Migas in 2023 — Insomnia, Daytime Sleepiness, and Quality of Life among 20,139 College Students in 60 Countries around the World—A 2016–2021 Study|| The study found that 28.3% of the college students reported having insomnia, while 35.6% reported experiencing daytime sleepiness. These sleep disturbances had a significant impact on the students' quality of life, affecting their academic performance, social activities, and mental health. The study also found that certain demographic factors were associated with a higher prevalence of insomnia and daytime sleepiness. For example, students who reported having chronic medical conditions or mental health disorders were more likely to experience sleep disturbances. Additionally, students who reported engaging in less physical activity and spending more time using electronic devices were also more likely to report these sleep issues. The study's authors have called for increased awareness of the prevalence and potential impact of sleep disturbances among college students. They suggest that educational programs promoting good sleep hygiene and increased access to mental health resources may help address this issue and improve the overall well-being of college students around the world.

Ayanthi Wickramasingha, Brigitte Essen, Rajendra Surenthirakumaran and Pia Axemo in 2023 —Prevalence of depression among students at a Sri Lankan University|| this study stated that the prevalence of mental health



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disorders is known to be high among university students globally. Currently there are only a few studies on depression among university students in Sri Lanka. The aim of this study was to screen for the prevalence of Major Depressive Disorder (MDD) and other forms of depression, and to evaluate the factors associated with MDD. MDD was considered to have been experienced by 31% of the students. From all three faculties, 70% of the students claimed to have experienced some form of depression ranging from mild to severe. The factor associated with MDD was the students' ethnicity. Due to the high MDD risk among university students, it is imperative to develop psychosocial interventions to ensure early detection of mental health disorders and provide adequate support to safeguard this vulnerable population.

N.Italiano, F. Di Cianni, D.Marinello, E.Elefante, M.Mosca and R.Talarico in 2022 —Sleep quality in Behçet's disease|| . The studies showed that BD patients have lower sleep quality compared to healthy individuals, with increased sleep disturbances such as longer sleep latency, frequent awakenings during the night, shorter sleep duration, and increased daytime sleepiness. Moreover, several sleep disorders were identified in BD patients, such as obstructive sleep apnea, restless leg syndrome, and periodic limb movement disorder. Overall, the evidence suggests that sleep disturbances and sleep disorders are common in BD patients, and they significantly impact their QoL. However, the underlying mechanisms linking BD to sleep disturbance are still unclear. Some studies suggest that high levels of proinflammatory cytokines, such as interleukin-6 and tumour necrosis factor alpha, are associated with both BD and sleep disturbances. Other potential factors that may contribute to sleep disturbances in BD patients include pain, anxiety, depression, and medication side effects. In conclusion, this SLR indicates that sleep disturbances and specific sleep disorders are prevalent in BD patients, indicating that sleep disorders should be addressed as part of the overall management of BD patients. More research is needed to determine the underlying mechanisms linking BD and sleep disorders and to develop effective treatments to alleviate sleep disturbances and improve QoL in BD patients.

Juengst SB, Kumar RG, Wagner AK in 2017 —review of depression following traumatic brain injury: prevalence, impact, and management challenges|| where the study found that individuals with pre-existing depression or anxiety may be more susceptible to developing PTSD after a TBI, highlighting the need for clinicians to be aware of these risk factors and provide appropriate monitoring and support. The study also pointed to the importance of early identification and treatment of PTSD, as it can significantly impact an individual's recovery and quality of life. Moreover, the study highlights the importance of a multidisciplinary approach to the treatment of PTSD, involving neuropsychologists, psychiatrists, and rehabilitation specialists. The treatment plan should address the individual's specific needs and incorporate evidence-based therapies such as cognitive behavioural therapy, problem-solving therapy, and pharmacotherapy. Additionally, family and social support can also play a crucial role in the management of PTSD. Furthermore, the study highlights the need for further research to better understand the underlying mechanisms of PTSD and to identify effective treatments. Specifically, studies should explore the contribution of biological factors such as inflammation or hormonal changes, as well as psychosocial factors such as coping strategies and social support networks. In conclusion, PTSD is a common and complex condition that can significantly impact an individual's recovery and quality of life after a TBI. Early identification and personalized treatment that considers both biological and psychosocial factors are crucial for successful management and improved outcomes. Therefore, healthcare providers and researchers should prioritize the development of effective strategies to address PTSD in individuals with TBI.

Sarah Naushael, Waseem Farooqui, Satish Sharma, Mukthi Rani, Rajashree, Singh and Supreet Verma in 2014 —Study of proportion and determinants of depression among college students in Mangalore city||. The study found that the prevalence of depression among college students in Mangalore city was 45.6%, with the highest prevalence among female students (54.6%). Factors that were found to be significantly associated with depression included family history of psychiatric illness, lack of family support, financial stress, academic pressure, and relationship problems. The study highlights the need for awareness programs and interventions to promote mental health and well-being among college students. Moreover, the study emphasizes the importance of identifying and addressing the risk factors associated with depression in adolescence. The findings highlight the need for a coordinated effort



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between healthcare providers, educators, and families to prevent and manage depression in young adults. Early screening and intervention can mitigate the negative consequences of depression and improve the quality of life for affected individuals. Overall, the study supports the need for a comprehensive and proactive approach to mental health among college students.

Antonina Luca, Maria Luca and Carmela Calandra in 2013 —sleep disorders and depression: case report, and nonpharmacologic interventions for depression|| The study study that it is important to note that sleep disorders can also arise as a consequence of medication use or as a comorbid condition with other medical conditions such as chronic pain, anxiety, and substance abuse. The authors of the study also discussed non-pharmacologic interventions for depression, which include cognitive-behavioural therapy, interpersonal therapy, and mindfulness-based interventions. These interventions have been shown to improve sleep and reduce symptoms of depression by addressing negative thoughts and behaviours, improving coping skills and stress management, enhancing interpersonal communication, and promoting relaxation and mindfulness. Cognitive-behavioural therapy (CBT) is a type of talk therapy that focuses on identifying and changing negative thought patterns and behaviours that contribute to depression. CBT for insomnia (CBT-I) has been shown to be effective in treating comorbid depression and insomnia, by addressing negative thoughts and beliefs about sleep, promoting relaxation techniques, and implementing sleep hygiene practices. Interpersonal therapy (IPT) focuses on improving interpersonal communication and relationships in order to reduce symptoms of depression. By addressing interpersonal stressors and improving communication skills, IPT can improve social support, reduce isolation, and help individuals manage difficult life events. Mindfulness-based interventions, such as mindfulness-based stress reduction (MBSR) and mindfulness-based cognitive therapy (MBCT), incorporate mindfulness meditation and other techniques to promote awareness, acceptance, and self-compassion. By promoting presentmoment awareness and reducing negative thought patterns, these interventions can reduce symptoms of depression and improve sleep quality. Overall, non-pharmacologic interventions for depression can be effective in addressing sleep disorders and improving overall mental health. It is important for individuals with depression and/or sleep disorders to discuss treatment options with a healthcare professional and explore a variety of interventions in order to find the most effective approach for their individual needs.

Seithikurippu R. Pandi-Perumal, Jaime M. Monti, Deepa Burman, Ramanujam Karthikeyan, Ahmed S. Bahammam, David Warren Spence, Gregory, M. Brown, Meera Kardashian in 2020 —Clarifying the role of sleep-in depression|| where this study stated that depression, disrupted sleep quality, insomnia, or hypersomnia commonly observed in affected individuals. However, the relationship between sleep and depression is complex and involves bidirectional interactions, as poor sleep quality can both contribute to and result from depressive symptoms. In this study, the authors aimed to clarify the role of sleep-in depression by reviewing the current literature on the topic. The authors discuss the neurobiological mechanisms underlying the relationship between sleep and depression, including disruptions in neurotransmitters such as serotonin and norepinephrine, dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, and alterations in the expression of clock genes that regulate circadian rhythms. Additionally, they discuss the impact of sleep deprivation and disturbed sleep on cognitive functions, emotional regulation, and overall health, which may exacerbate depressive symptomatology. The authors conclude that sleep disturbances and depression are intricately intertwined and that addressing sleep problems is a crucial aspect of depression treatment. They suggest that improving sleep hygiene, implementing cognitive-behavioural therapy for insomnia, or utilizing pharmacotherapy such as melatonin or sedatives can be effective interventions for managing depressive symptoms. They also highlight the importance of future research in better understanding the mechanistic basis of the sleep-depression relationship and identifying personalized treatment strategies for affected individuals. Overall, this study emphasizes the relevance of considering the role of sleep-in depression management and highlights the need for integrated treatment approaches that address both sleep and depressive symptomatology





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MATERIALS AND METHODS

Sample: The required samples or population for this research constitutes of youths from 19-25 years of age. However, for the samples of case study there are no age limitations.

Sample Size: A sample size of 100 college students were taken

Sampling Method/Technique: For this research, simple random sampling technique was used

Operational Definitions:

Sleep Deprivation- According to American Psychological Association, sleep deprivation is defined as —The condition of getting insufficient sleep. This may occur as a result of illness, shift work or lifestyle consideration.

Depression- According to American Psychological Association Depression is defined as —Negative affective state, ranging from unhappiness and discontent to an extreme feeling of sadness, pessimism and despondency that interferes with daily life.

The operational definition of sleep deprivation is a general term to describe a state caused by inadequate quantity or quality of sleep, including voluntary or involuntary sleeplessness and circadian rhythm sleep disorders.

The operational definition of depression is that it is characterized by persistent sadness and a lack of interest or pleasure in previously rewarding or enjoyable activities.

Research Design: The research design that was used for this research is quantitative with a correlational design.

Data Analysis: The data for this research was collected through Google-Form for the quantitative study; the questionnaire was circulated in Google-Form as it is more convenient to reach out to larger population and less time consuming.

Tools used: The tools required for the completion of this research were:

Sleep Quality Scale (SQS) and

Beck Depression Inventory (BDI)

Procedure

- This research study includes the participation of college students from different universities
- In this research, the data is to be collected from both genders using the Sleep Quality Scale and Beck Depression Inventory
- For less time consuming in collection of the data, the questionnaire for quantitative study it will be circulated through Google-Form and it is more convenient for surfacing it to larger population or samples.
- On the process of collecting the data, consents and confidentiality of the participants will be maintained.
- After the collection of the data required for this research study is done, the researcher will further scrutinize the data using appropriate statistical tool.

RESULTS AND DISCUSSION

According to findings of the data collected, the T value of sleep deprivation by using 2 tailed the result is **0.723** where it is stated that **0.723** is greater than **0.05** there is no significant difference between the gender with reference to sleep deprivation. The T value of depression by using 2 tailed, the result is **0.406** where here it is also greater than **0.05** therefore there is no significant difference between the gender with reference to depression. These results suggest that there is no relationship between gender and sleep deprivation or depression. In other words, both men and women are equally likely to experience sleep deprivation and depression regardless of their gender. The T value is a statistic used to determine if there is a significant difference between two groups. In this case, the two groups are males and females, and the variables being compared are sleep deprivation and depression. In statistical analysis, the T value is used to assess whether the difference between two groups is large enough to be considered statistically significant. In order to determine if the T value is significant, it is compared to a critical value. The critical value is determined by the level of significance, which is typically set at 0.05. In this study, both T values for sleep deprivation and depression were found to be greater than 0.05. This means that the difference between males and females with respect to these variables is not statistically significant. Therefore, we can conclude that there is no



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significant difference between males and females in terms of their experiences with sleep deprivation and depression. It is important to note that these findings are specific to this particular study and may not be generalizable to other populations or contexts. However, they do provide valuable information for clinicians and researchers who are interested in understanding the relationship between gender and mental health outcomes.

By using the Pearson correlation, the correlation between sleep deprivation depression value is **0.281** which states that there is a low positive correlation between the two variables. A correlation coefficient of **0.281** suggests a low positive correlation between sleep and depression. In statistical terms, an r value between 0.2 and 0.4 is typically considered a weak or low positive correlation. Therefore, the correlation between sleep and depression in this case indicates a relatively small relationship between these two variables. It is important to note, however, that correlation does not necessarily imply causation and other factors may also be involved in the relationship between sleep and depression. For example, individuals with depression may find it difficult to sleep and experience insomnia, or they may oversleep as a coping mechanism. On the other hand, individuals with sleep disorders may be more likely to experience depression due to the impact of sleep disturbance on mood and brain function. Therefore, while a low positive correlation has been observed between sleep and depression, it is important to consider the broader context and additional factors that may be influencing this relationship.

Based on the given information, it can be concluded that there is no significant difference between males and females in terms of the relationship between sleep deprivation and depression. The T-values of sleep deprivation and depression were **0.723** and **0.406**, respectively. These T-values suggest that the difference between males and females in their experience of sleep deprivation and depression is not statistically significant. In other words, the study found that both males and females appear to be equally affected by sleep deprivation and depression. The T-value represents the magnitude of the difference between two groups or variables, and a value of 0 indicates no difference between the groups. Therefore, based on the T-values reported in this study, there is no significant difference between males and females with regards to their experience of sleep deprivation and depression.

A correlation coefficient of .281 suggests that there is a weak, yet positive correlation between sleep deprivation and depression among college students. This indicates that as the level of sleep deprivation increases, there is a small likelihood that the level of depression experienced by college students also increases. To understand this correlation better, it is essential to know what sleep deprivation and depression are and how they relate to each other. Sleep deprivation is the condition of not getting enough sleep, which may occur due to various reasons such as lifestyle, stress, or other medical conditions. It is commonly associated with symptoms such as difficulty concentrating, decreased alertness, fatigue, and irritability. On the other hand, depression is a mental health disorder characterized by persistent feelings of sadness or loss of interest in everyday activities. It can also result in changes in sleeping patterns, including difficulty falling or staying asleep, or oversleeping. Sleep deprivation can have a negative impact on mood, cognitive performance, and overall physical health. When college students experience sleep deprivation, it can cause irritability, difficulty concentrating, lack of motivation, and fatigue. These symptoms can lead to feelings of sadness and hopelessness, which are common signs of depression. At the same time, depression can also negatively impact sleep patterns among college students. Depressed individuals may experience difficulty falling asleep, staying asleep, and may wake up earlier than desired. This can create a vicious cycle where sleep deprivation exacerbates depressive symptoms and depression leads to further sleep disturbances. It is not entirely clear how sleep deprivation is leading to depression among college students, but it is speculated that disruptions in circadian rhythms, which regulate sleep and other physiological processes, may play a role. Additionally, stress associated with academic demands and social pressures may contribute to both sleep deprivation and depression. It is important to note that while the correlation between sleep deprivation and depression among college students is low, addressing sleep-related issues can still have a positive impact on mental health and well-being. Promoting healthy sleep habits, such as establishing a consistent sleep schedule, optimizing sleep environment, and avoiding caffeine before bedtime, can benefit both sleep quality and mental health. Additionally, seeking support from healthcare professionals and mental health services can be beneficial in addressing issues related to sleep and depression.



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The correlation coefficient of 0.281 indicates a positive relationship between sleep deprivation and depression. This means that as sleep deprivation increases, the level of depression reported also slightly increases. However, the correlation is considered a weak positive correlation, meaning it is not strong enough to conclude that sleep deprivation directly causes depression or that depression directly causes sleep deprivation. Furthermore, it's important to note that the correlation coefficient only measures the strength and direction of the relationship between two variables and does not imply causation. Therefore, it is difficult to determine the exact relationship between sleep deprivation and depression in college students based solely on the correlation coefficient. While the correlation between sleep deprivation and depression among college students is weak, it is still significant. It highlights the importance of maintaining healthy sleep habits for mental well-being.

Based on the findings of the study, here are some recommendations:

- Prioritize sleep by making sure one is getting enough sleep every night to help prevent the development of depression. It is essential to get at least 7-9 hours of sleep per night.
- Create a bedtime routine by establishing a relaxing bedtime routine that can help you unwind and prepare for sleep. This can include activities such as taking a warm bath, reading a book, or practicing relaxation techniques such as meditation or deep breathing.
- Address underlying mental health issues if one is experiencing symptoms of depression, it is important to seek professional help. This may include therapy, medication, or a combination of both
- Practice relaxation techniques like deep breathing, meditation, or progressive muscle relaxation can help reduce stress and ease anxiety, which can improve sleep quality.

CONCLUSION

The findings of this research suggest a low positive correlation between sleep deprivation and depression. This means that there is a relationship between these two variables, but the relationship is not very strong. Sleep deprivation refers to the condition of not getting enough sleep. This could be due to various reasons, such as staying up late to study or work, having insomnia, or having a sleep disorder. Depression, on the other hand, is a mental health disorder that is characterized by persistent feelings of sadness, hopelessness, and loss of interest or pleasure in activities. The correlation between sleep deprivation and depression can be explained by the fact that sleep plays a vital role in regulating mood and emotions. When individuals do not get enough sleep, their mood is likely to be affected, leading to symptoms of depression such as irritability and lack of energy. Moreover, sleep deprivation can also lead to a decrease in the production of neurotransmitters such as serotonin, which can contribute to the development of depression. However, while there is a relationship between sleep deprivation and depression, the correlation is not very strong. This means that not everyone who experiences sleep deprivation will necessarily develop depression, and vice versa. Other factors such as genetics, personality traits, and life events can also influence an individual's risk of developing depression. In conclusion, while there is a low positive correlation between sleep deprivation and depression, it is important to recognize that they are complex and multifactorial conditions that require individualized treatment and holistic approaches.

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RESEARCH ARTICLE

Nutritional Status and Age of Menarche in Adolescent Girls of Chennai Schools

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ABSTRACT

Puberty is a result of integrated function of Hypothalamo-pituitary-gonadal axis and there are various factors that influences the age of menarche which includes genetic (sex, race, parental influence), socioeconomic status and environmental conditions(body fatness, nutrition). The aim of the present study was to determine the menarcheal age and to examine the relationship between current age at menarche with anthropometric measures in school girls in Chennai (urban sector), Tamilnadu, India. This was a cross-sectional study conducted on 783 adolescent girls aged 10-15 years were enrolled based on a purposive sampling technique. The participants who were post-menarcheal were asked to recall the year and month of menarche and was noted. To assess the nutritional status, the parameters weight(Kg), height (Cm) and waist circumference (cm) were measured .The BMI -for-Age and WHtR were calculated. The mean age of menarche is observed in this study participants was 11.14 ± 1.34 years. The Prevalence of central obesity ranged from 3.5% to 15.9% (WHtR of WHO Standards) and according to Chennai Cut-off points the central obesity varies between 2.4% to 12%.In terms of urban subjects studied, only 20.4 % of participants from the study population were exhibiting risks of obesity and overweight as per WHO standards of BMI, but were found to be 'Without risk' according to WHtR. Thus, the degree of non-risk prevalence among BMI categorized overweight/ obese groups is greater compared to almost 75.7% of

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participants from the study groups exhibiting greater risk of obesity/ overweight as per WHtR but were found to be 'without any risks' as per BMI. This study concluded that abdominal fat plays a major role in the adolescent period mainly during menarche, henceforth WHtR should be measured along with BMI in the upcoming studies. The counseling session and important of nutrition role in daily life were accentuated.

Keywords: Menarcheal age, abdominal obesity, Waist- to Height Ratio (WHtR), Body Mass Index (BMI), World Health Organization (WHO), Socio Economic Status (SES)

INTRODUCTION

During adolescence, the intricate interplay between growth, hormonal changes, and body composition takes center stage, contributing significantly to overall health and development. Among the various factors influencing this critical phase, abdominal fat and its implications, particularly in proximity to menarche, have gained considerable attention. The understanding of how these factors relate to health outcomes in adolescents is essential for shaping effective public health strategies. This introduction delves into the pivotal role of abdominal fat during adolescence, specifically around the time of menarche, and highlights the significance of integrating the Waist-to-Height Ratio (WHtR) alongside the Body Mass Index (BMI) in research endeavors. While the Body Mass Index (BMI) has long been used as a standard measure of body composition, the Waist-to-Height Ratio (WHtR) has emerged as a promising complement. Considering the unique metabolic implications of abdominal fat, WHtR provides a more nuanced insight into health risks associated with body composition, particularly in adolescents. Hence, the integration of WHtR alongside BMI can offer a comprehensive understanding of the interplay between growth, fat distribution, and health during adolescence.

The first menstrual period a female adolescent experience is known as menarche. Menarche usually begins between the ages of 10 and 16, with an average age of 12.4 years. Menarcheal age factors are still being investigated, but socioeconomic position, genetics, general health, dietary status, physical activity, seasonality, and family size are likely to be important factors. Menarche typically happens suddenly and without pain. Usually anovulatory, the first cycles can vary in length and flow. Menarche is a crucial milestone in the development of secondary sexual traits and marks the onset of reproductive capacities. Body size parameters, similar as weight or BMI and height are explosively identified with the age at menarche[1]. A decrease in the mean age of menarche has been observed in adolescent girls compared to their mothers. Adolescent girls reach menarche earlier than their mothers, and this difference is due to their sedentary lifestyle[2]. Age at menarche was distributed normally, with a mean of 12.4 years in the study's sample. In comparison to their premenarchal classmates, the girls who achieved menarche were identified to be taller, heavier, and had higher BMIs. They also had larger waist and hip circumferences. Post menarchal females had a lower waist-hip ratio and a greater waist-to-height ratio than premenarchal girls. Compared to girls from middle and high SES, those with low SES experienced a delayed menarche. The SES and variations in several anthropometric parameters that represent the development status of females were linked to the age at menarche.[3]. The intricate relationship between childhood obesity and early menarche, emphasizing the complex interplay of hormones, metabolic factors, and physiological processes. The findings strengthen existing evidence by establishing childhood obesity as an autonomous risk factor for central precocious puberty (CPP), regardless of other influential variables like birth weight, breastfeeding duration, parental overweight, and socioeconomic conditions such as household income. This highlights the substantial impact of obesity on reproductive development, particularly among girls, and underscores the importance of extended overweight and obesity exposure exceeding one year in contributing to the likelihood of early menarche[4]. Early menarche is correlated with overweight, indicating that girls who experience puberty earlier may have a higher likelihood of being overweight. On the other hand, delayed menarche is associated with an increased risk of underweight, suggesting that girls who mature later might face a heightened vulnerability to being underweight[5]. The age at



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menarche was correlated with socioeconomic status (SES) and led to observable changes in various anthropometric measurements that reflect the growth status of girls[6]. The Waist-to-Height Ratio (WHtR) cutoff value effectively predicts central obesity in children and adolescents across different races, ages, and genders. While the theoretical cut-off is 0.49, a more practical value of 0.5 is recommended for ease of use[7]. WHtR predicts the consequences of obesity and has a strong connection with body fat[8]. With increasing age at menarche, the values of the anthropometric parameters declined. Menstruation that begins before the age of 12 has been associated with an increased risk of obesity and overweight (BMI 25), as well as abdominal obesity (WC > 80 cm and/or WHtR 0.5). First period occurring beyond the age of 14 years was linked to both a higher risk of underweight (BMI 18.5 and/or WHtR 0.4) and a decreased risk of obesity and overweight (BMI 25, WC > 80 cm and/or WHtR 0.5)[5]. The aim of the present study was to determine the menarcheal age and to examine the relationship between current age at menarche with anthropometric measures in school girls in Chennai (urban sector), Tamilnadu, India

Objectives

Specific Objectives of this Study were the following

1. To assess the incidence of overweight and abdominal obesity through the measurements of BMI (Body Mass Index) and WHtR of school-going girls aged ten to fifteen years in Chennai (urban sector), Tamilnadu, India.
2. To determine the distribution of WHtR percentiles and cut-offs for abdominal obesity for school going girls aged ten years to fifteen years and to classify overweight and obesity through the optimal waist to height ratio cut-off points.
3. To analyze and compare the risk and non-risk categories on the basis of BMI for age [WHO standard] Versus WHtR [WHO standard] [9] and WHtR (Chennai) cut-off points.[10]

METHODS AND MATERIALS

Participant Selection: A community based observational study was conducted among school going adolescent girls of age between 10-15 years in the city of Chennai, India. Study protocol was approved by the Institute Ethics Committee (Ref:CSP/23/JAN/120/17) and permission letter was obtained from the Principal of each schools.

Sample Size and Sampling Technique: The sample size was recruited using inclusion and exclusion criteria. The total number of samples taken for this study is N=738. The sampling technique employed to carry out was convenient sampling technique. The study was conducted during the period of October 2022- March 2023. Inclusion criteria includes the schools which are willing to give permission for data collection, School going girls of age between 10-15 from Chennai schools, girls who have attained their menarche and girls who are willing to participate were included in the study, whereas girls who cannot recall their menarche date and girls who are in any medication over a month were excluded from the study.

Method of Data Collection: Permission letter was attained from the principal of the selected schools and written consent was attained from the parents of the students and assent was obtained from the students prior to the measurements of anthropometric. Height of the children was taken using growth stature meter. The maximum distance from the floor to the highest point of the head, when the subject is facing directly ahead was measured. The subjects was asked to remove their shoes, feet together, and arms by the sides. Heels, buttocks and upper back were also in contact with the wall when the measurement was made[11] (**Fig 1**). Weight of the children was taken using weighing scale. The scale was placed on firm flooring (such as tile or wood) rather than carpet. The children were asked to remove their shoes and heavy clothing, such as sweaters. And the children were made to stand on the weighing scale with both feet in the centre of the scale. The nearest decimal fraction was measured[12] (**Fig 2**). By dividing a person's weight in kilograms by their height in meters squared, or BMI = weight (in kg)/height (in m²),[13] the study participants were divided into four categories: obese (>95th percentile), overweight (85th->95th percentile), normal weight (5th-<85th percentile) and underweight (<5th percentile).[14] Waist circumference of the children was measured using a measuring tape. The subjects were made to Stand and the measuring tape was placed around the





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middle, just above the hipbones without compressing the skin[15] (Fig 3). Socio Demographic Data was taken using Kuppuswamy socioeconomic scale[16]. WHtR was determined using the formula: waist circumference (cm) divided by height (cm) (WC/Ht). To measure the central obesity ratio, WHtR was used with the discriminatory values of ≥ 0.500 . Therefore, two children groups were isolated. One group of children belongs to the absence of central obesity of WHtR < 0.500 and the other to presence of central obesity and central fat distribution of WHtR ≥ 0.500 [9]. The Chennai cut-off values for WHtR among the study participants were categorized as <0.43 (Normal), >0.43 (Overweight) and >0.52 (Obesity).[10]

Statistical Analysis

Data entry and analysis was performed using the “Statistical Package for Social Science” (SPSS) 22 version. Each and every entry were ensured and verified. The occurrence of obesity, overweight, and abdominal obesity are given as frequency (n) and percentage.

RESULTS AND DISCUSSION

A total of 738 post- menarcheal adolescent girls were subjected to the study in which many participants were predominantly belong to the age of 13years (22.5%) which was followed by 12years (17.3%) and 14years (16.5%) showed in **Table 1**. The menarche age and their current nutritional status are shown in **Table 2**. According to the BMI-for-Age distribution respondents with normal (72.2 %) were more than underweight (8.2%) and overweight/obese respondents (15%, 3.3%). The study provides additional evidence in favour of the secular trend in menarche onset age because the mean age of menarche in the current sample of Chennai girls (Urban Sector) is 11.14 ± 1.34 years which is very astonishingly near to the results of earlier research conducted in Chennai (17). **Table 3** shows the distribution of BMI ranges by selected socio-demographic variables. The highest percentage of respondents of normal BMI-for-Age was noted in CLASS 2 (Upper Middle) 29.6% followed by CLASS 3 (Lower Middle) 29%, CLASS 1 (Upper) 11.5 % and CLASS 4 (Upper Lower) 2.5 %. and the lowest percentage of respondents were observed in obese category under all SES, whereas the of CLASS 5 (Lower) category were not found.

Table 4 shows the frequency of post-menarcheal status of studied group according to BMI-for-Age categories. Among the participants, the highest proportion of children with normal BMI was observed among the 13-year-old (n=118) followed by 12 (n=102) and 11-year (n=89) old children. Obesity was the highest among the 14-year olds (n=13) and 15-year olds (n=8) and overweight was highest among 13-years olds (n=35) followed by 15-year olds (n=27) and 14-year-olds (n=22). Table 5 shows that age-based prevalence governing with mean WHtR ranges among school going girls. This showed that in majority (61.9%) of the participants had a central obese accretion consistent with obesity of abdominal region (WHtR ≥ 0.500). Around 38.1% of the participants had a normal fat distribution (WHtR < 0.500). Among the investigated age groups within the WHtR of WHO Standards, central obesity ranged from 3.5 to 15.9%. The investigated age groups according to the Chennai cut-off points: without central obesity (WHtR < 0.43), the total is 10.7%; whereas with central obesity and overweight (WHtR ≥ 0.52 and ≥ 0.43), the total is 45.1% and 44.1%. The prevalence of central obesity among students varies between 2.4% to 12%.

The prevalence of central obesity in total population (n=738) is shown in Table 6. A total of 38 % (WHtR < 0.500) were underweight normal and overweight (n=281) and using the threshold of WHtR > 0.500 , the total prevalence of central obesity were 61.9% (n=457) of the entire population. According to BMI-for-Age, a total of 96.7% of the total (n=62) were found to be normal (WHtR < 0.500). Despite found underweight with BMI-for-Age, 3.3% of the total were found to be having central obesity (WHtR > 0.500). A comparison between Waist -to Height Ratio and BMI showed that at least 59.4% (n=319) and 97.4 % (n=111) of the children who were obese using WHtR were either overweight or normal using BMI-for-Age. Among the group of obese participants, 100 % (n=25) had simultaneous central obesity. Based on risk and non-risk categories of BMI versus WHtR cut-off points, the following outcomes were observed in Table 7. Among the total 738 participants. The cut-off values for WHtR in the urban children categorized as <0.43 (Normal), >0.43 (Overweight) and >0.52 (Obesity) is discussed below



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- Among the underweight criteria according BMI –for- age (n=62), 66.1 percentage (n=41) participants were normal, 32.2 percentage (n=20) were overweight and 1.7 percentage (n=1) were obese according to WHtR.
- Under normal criteria (n=537) of BMI for age it was observed that 7.1 percentage (n=38) participants were normal, 56 percentage (n=301) were overweight and 36.9 percentage (n=198) were obese according to WHtR. While 50.54 Percentage of study population (i.e., $n=301 + n=198 = 499/537 = 92.9\%$) were observed to be falling under normal category BMI-for-Age. From the observed overweight criteria (n=114) according to BMI for the age, 4.4 percent (n=5) of participants were overweight and 95.6 percent (n=109) were obese according to WHtR and from the observed obese category (n=25) of BMI for the age, 100 percent (n=25) were obese according to WHtR.
- With WHtR < 0.43 a total of 10.70 % (n=79) of the total participants were considered to be normal, > 0.43 a total of 44.17 % (n=326) of the total participants were considered to be Overweight and 45.12% (n=333) with WHtR > 0.52 falling under obesity.
- In terms of urban subjects studied, only 20.4 % of participants from the study population were exhibiting risks of obesity and overweight as per WHO standards of BMI, but were found to be 'Without risk' according to WHtR. Thus, the degree of non-risk prevalence among BMI categorized overweight/ obese groups is greater compared to almost 75.7% of participants from the study groups exhibiting greater risk of obesity/ overweight as per WHtR but were found to be 'without any risks' as per BMI- for- Age.

CONCLUSION

The findings of this study underscore the significant role of abdominal fat during the adolescent phase, particularly around the time of menarche. As a result, it is recommended that Waist-to-Height Ratio (WHtR) be considered in conjunction with Body Mass Index (BMI) in future research endeavors. The World Health Organization (WHO) has established international standards for WHtR, but there's much to be gained from adjusting these standards to specific geographic regions. In particular, the criteria developed for the Chennai population, as validated in the study titled "Sensitivity and Specificity of Waist to Height Ratio (WHtR) as a Screening Tool for Assessment of Abdominal Obesity among Rural and Urban School Girls in Chennai, Tamil Nadu: A Comparative Cross-Sectional Study," assumes particular significance in the context of post-menarcheal girls. Furthermore, this study emphasizes the importance of conducting comprehensive, large-scale prospective evaluations to substantiate the applicability of WHtR. Such research endeavors should encompass diverse populations of children and adolescents, considering gender and ethnicity-specific variables. The study participants provided counsel on how nutrition enhances their everyday lives and information on lifestyle diseases and how nutrition can be utilized to prevent illness.

Limitation

- Our research has been carried out in only one large metropolitan city **and with restricted sample size**. The findings might not be representative of the whole country or even of the whole of Tamilnadu.
- Future prospective studies are needed to investigate the relationship between nutritional status and clinical consequences of early versus late menarche.
- **The association of age of menarche in a mother-daughter relationships**, lifestyle habits (Dietary Intake and Physical Activity) and non-school-going children were not included in the current research.

Conflict of Interest

The authors declare that there is no conflict of interest associated with this manuscript.





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Author Contribution Statement

Miss. Sneha Sri performed the measurements, Ms.T.H.Hema (**Research Supervisor**) were involved in planning and supervised the work, Miss. Sneha Sri processed the experimental data, drafted the manuscript and designed the figures. Statistical data was analysed by Dr.S.Porchelvan, M.Sc Stat-Loyola),MBA.,PG.DCA., Ph.D (Medical Stat-ICMR).Professor of BioStatistics, Panimalar Medical College Hospital And Research Institute, Chennai - 600123. India.

Novelty**What is New:?**

Extensive research evidence from various parts of the country conceives that waist- to -height ratio is a better indicator for central/ abdominal obesity. This study also highlights that waist- to- height ratio is more predictive particularly during the time of menarche than using a matrix based BMI. **The most significant aspect of the current research was the use of cut-off points for specific geographic areas (i.e., Chennai-Urban Sector).**

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Table-1: Frequency of Post-Menarcheal Adolescent Girls in Different Age Group Between Ten to Fifteen Years (N-738)

Age of Post -Menarcheal (in Years)	Number of Girls	Percentage of Post -Menarcheal
	(n)	(%)
10	109	14.8
11	110	14.9
12	128	17.3
13	166	22.5
14	122	16.5
15	103	14.0

Table-2: Age of Onset (Menarche) and Current Nutritional Status Aged Nine to Fifteen Years (N-738)

Age at Menarche (n=738)	Underweight ($<5^{\text{th}}$ percentile) (n=62)		Normal ($5^{\text{th}} - 85^{\text{th}}$ percentile) (n=537)		Overweight ($85^{\text{th}} - 95^{\text{th}}$ percentile) (n=114)		Obesity ($>95^{\text{th}}$ percentile) (n=25)		Total	
	n	%	n	%	n	%	n	%	n	%
9 (n=43)	9	1.2	33	4.4	1	0.1	-	-	43	5.8
10 (n=237)	26	3.5	184	24.9	25	3.3	2	0.2	237	32.1
11 (n=185)	14	1.9	138	18.7	27	3.6	6	0.8	185	25
12 (n=146)	7	0.9	98	13.2	31	4.2	10	1.3	146	19.7





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13 (n=94)	4	0.5	64	8.6	24	3.2	2	0.2	94	12.7
14 (n=30)	1	0.1	18	2.4	5	0.6	6	0.8	30	4
15 (n=3)	1	0.1	2	0.27	-	-	-	-	3	0.4

Table-3: Distribution of BMI Ranges by Selected Socio-Demographic Variables (N=738)

BMI-for Age	Revised Kuppuswamy Scale											
	Class 1 (Upper)		Class 2 (Upper Middle)		Class 3 (Lower Middle)		Class 4 (Upper Lower)		Class 5 (Lower)	Total		
	n	%	n	%	n	%	n	%	n	%	n	%
Underweight ($<5^{\text{th}}$ percentile)	10	1.3	28	3.7	23	3.1	1	0.1	-	-	62	8.4
Normal ($5^{\text{th}} - 85^{\text{th}}$ percentile)	85	11.5	219	29.6	214	29	19	2.5	-	-	537	72.7
Overweight ($85^{\text{th}} - 95^{\text{th}}$ percentile)	21	2.8	53	7.1	38	5.1	2	0.2	-	-	114	15.4
Obesity ($>95^{\text{th}}$ percentile)	4	0.5	12	1.6	8	1	1	0.1	-	-	25	3.3

Table-4: Post-Menarcheal Status of Studied Group according to BMI-for Age Categories (N=738)

Age(Years)	Underweight $<5^{\text{th}}$ percentile	Normal 5^{th} – 85^{th} percentile	Overweight 85^{th} – 95^{th} percentile	Obese $>95^{\text{th}}$ percentile
10 (n=109)	26	76	7	-
11 (n=110)	10	89	10	1
12 (n=128)	11	102	13	2
13 (n=166)	10	118	35	3
14 (n=122)	3	84	22	13
15 (n=103)	2	68	27	8
Total	62	537	114	27

Table 5: Age-Based Prevalence Governing with Mean WHtR Ranges Among School Going Girls (N=738)

Central Obesity Characteristics	10 -years (n=109)		11 -years (n=110)		12 -years (n=128)		13 -years (n=166)		14 -years (n=122)		15 -years (n=103)		Total (n=738)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
WHO Cut-off Points														
WHtR <0.5 (Normal)	83	11.2	42	5.6	44	5.9	48	6.5	35	4.7	29	3.9	281	38.1
WHtR ≥ 0.5 (At Risk)	26	3.5	68	9.2	84	11.3	118	15.9	87	11.7	74	10	457	61.9
Chennai Cut-off Points														
WHtR <0.43 (Normal)	49	6.6	12	1.6	8	1	7	0.9	2	0.2	1	0.1	79	10.7
WHtR >0.43 (Overweight)	42	5.6	56	7.5	62	8.4	70	9.4	51	6.9	45	6	326	44.1
WHtR >0.52 (Obesity)	18	2.4	42	5.6	58	7.8	89	12	69	9.3	57	7.7	333	45.1





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Table 6: Comparative Assessment on Anthropometric Measurements via WHO Standards of BMI Versus WHtR Determine Risk & Non-Risk Categories (Underweight, Normal, Obese & Overweight) Among Adolescent Girls(N=738).

Categories According to BMI-for-Age	Number with WHtR <0.5 (Normal) (n=281)		Number with WHtR >0.5 (At Risk) (n=457)		% of participants at risk by WHtR but without risk according to BMI	% of participants at risk by BMI but without risk according to WHtR
	n	%	n	%		
Underweight(<5 th percentile) (n-62)	60	96.7	2	3.3	319/537 (59.4)	281/713 (39.4)
Normal (5 th – 85 th percentile) (n-537)	218	40.6	319	59.4		
Overweight(85 th – 95 th percentile) (n-114)	3	2.6	111	97.4		
Obesity(>95 th percentile) (n-25)	-	-	25	100		
Total (n=738)	281 (38%)		457 (61.9%)			

Table 7: Comparative Assessment on Anthropometric Measurements via WHO Standards Of BMI Versus WHtR (Chennai Cut-off Points) to Determine Risk & Non-Risk Categories (Underweight, Normal, Obese & Overweight) Among Adolescent Girls (N=738)

Categories According to BMI-for-Age	WHtR <0.43 (Normal) (n=79)		WHtR >0.43 (Overweight) (n=326)		WHtR >0.52 (Obesity) (n=333)		% of participants at risk by WHtR but without risk according to BMI	% of participants at risk by BMI but without risk according to WHtR
	n	%	N	%	n	%		
Underweight (<5 th percentile) (n-62)	41	66.1	20	32.2	1	1.7	499/659 (75.7%)	41/201 (20.4%)
Normal (5 th – 85 th percentile) (n-537)	38	7.1	301	56	198	36.9		
Overweight(85 th – 95 th percentile) (n-114)	-	-	5	4.4	109	95.6		
Obesity(>95 th percentile) (n-25)	-	-	-	-	25	100		
Total (n=738)	79 (10.70%)		326 (44.17%)		333(45.12%)			





Uncovering Obstacles: A Study of Residential Schools for Visually Impaired Children

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ABSTRACT

This study delves into the unique challenges encountered by visually impaired children attending residential schools. Through a comprehensive analysis of educational and social obstacles, it aims to shed light on the experiences of these students, emphasizing the importance of equal education for them. The research investigates the effectiveness of residential schools in providing specialized support and fostering an inclusive learning environment. In this context, two residential schools were selected for the study, and data were collected from 30 students enrolled in these schools. Findings from this study contribute to a better understanding of the hurdles that visually impaired children face in their educational journey, providing valuable insights into potential enhancements for their educational experiences.

Keywords: Visual impairment; Residential schools; Challenges; Educational Experiences

INTRODUCTION

Our universe is enriched by its diverse cultures, but unfortunately, some individuals are unable to experience this beauty due to their inherent visual limitations. (Inclusion Press, 2019, UNESCO (1994) emphasizes the importance of inclusive education, where all children, regardless of their difficulties or differences, learn together. Inclusive schools must cater to diverse student needs, adapting teaching methods, curriculum, and resources to ensure quality education for all (Evans & Lunt, 2002). This approach fosters child-to-child learning and involves parents and

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communities in planning and implementing services, benefiting all children, including those with disabilities. Unfortunately, students with disabilities, especially the visually impaired, often struggle to access their right to education (Salminen & Karhula, 2014). The United Nations General Assembly's adoption of the Convention on the Rights of Persons with Disabilities in December (2006) marked a crucial step in addressing legislative and societal barriers to inclusion. However, many interventions for persons with disabilities, including those with visual impairment, are often viewed through the lens of aid, rather than empowerment.

Visual Impairment and Its Impact on Learning

Visual impairment encompasses the loss of vision, even when individuals use corrective lenses. It results from eye diseases, accidents, or congenital eye conditions. Students in educational institutions face a multitude of challenges due to visual impairments, which significantly impact their academic performance. Visual impairment is classified as either blindness or low vision, both of which impose limitations on students. This group of learners with visual impairments presents a diverse range of problems and difficulties that demand careful consideration when implementing curricula and instructional systems to support their academic success. The academic performance of visually impaired students is notably hindered (Vanderpuye *et al.*, 2022). They encounter difficulties not only in grasping academic concepts but also in completing assignments and taking exams. To address the problems faced by these students, there is a growing need for more special needs education teachers who are highly skilled and proficient in carrying out their duties (Abubakar *et al.*, 2015). Teaching Braille and other subjects in whom senses other than sight come into play are initial and visible efforts to cater to the needs of visually impaired students. However, providing for this student group must extend beyond merely adapting tool subjects. Those who are born without sight or lose their sight early in life must construct their understanding of the world primarily through their remaining senses, which heavily rely on tactile and auditory perception as well as kinesthetic experiences. While auditory perception can provide some information about distance and direction, it does not convey existing ideas about objects. For blind students, the role of the sense of hearing is primarily to facilitate verbal communication and aid in navigation. Consequently, hearing has limited value in providing tangible insights into objects for blind students.

Justification of the Study

Education plays a pivotal role in fostering social inclusion. Investigating the challenges faced by visually impaired children can help identify ways to enhance their participation in the broader society, breaking down stereotypes and promoting diversity and inclusion (Jiménez-Corona *et al.*, 2014). Inclusive education is a fundamental human right, as underscored by international agreements and conventions. Visually impaired children often encounter significant barriers to accessing quality education. Investigating these challenges is crucial to understanding the disparities they face in educational opportunities compared to their sighted peers (Augustad, 2017). As we know that vision, as the most actively used sense, significantly shapes an individual's cognition and experiences. Visual impairment places fundamental limitations on one's abilities, particularly in the case of visually impaired children who are often deprived of a diverse range of experiences. These children face challenges in controlling their environment and understanding their relationship with it. While societal attitudes toward the visually impaired are evolving, stereotypes still persist, casting doubt on their abilities and potential (Heppe *et al.*, 2019). This study holds the potential to contribute to human development in our society, with students representing the future. As students undergo various physical, mental, and social changes, it becomes the moral responsibility of educators to comprehend and address their unique challenges. Emotionally, socially, and educationally well-adjusted students are invaluable assets to society and can serve as role models for others (Demmin & Silverstein, 2020). By uncovering the specific obstacles faced by visually impaired children in residential schools, the study can lead to the implementation of tailored support systems and strategies that improve the overall educational experience and academic performance of these students (Desrosiers *et al.*, 2009). Findings from this study can inform policy changes and curriculum adaptations to better serve visually impaired students in residential schools. It can drive improvements in specialized support, accommodation, and the development of inclusive learning environment. The research objectives have been tackled as follows in the study:



**Monika et al.,****Objectives of the Study**

- Investigate the institutional context, specifically focusing on infrastructure and human resources.
- Examine the educational challenges faced by visually impaired children.
- Evaluate the perspectives of school principals, teachers, and visually impaired children concerning school operations.
- Provide recommendations for enhancing the educational experience of visually impaired children.

METHODOLOGY

This study employed a descriptive survey design to investigate challenges experienced by visually impaired students in schools. The research involved 30 visually impaired children attending Residential Schools for the Visually Impaired in the Jammu district. Data collection methods included a self-designed interview schedule (questionnaire), participant observation, and group discussions with both teachers and students. The collected responses were then transformed into frequencies and percentages for data analysis. To ensure tool validity, the researcher consulted with experts for their inputs and for the administration of the tool researcher visited selected schools, where the investigator briefed school administrators, clarified the study purpose to the respondents, and ensured the discreet collection of data.

Interpretation and Analysis of Data

Analysis involves a rigorous evaluation of data to understand the key characteristics of the study. In this study, data was gathered from 30 visually impaired children and 8 teachers through an interview schedule. Subsequently, the data was encoded, decoded, and transformed into tables and diagrams for clear presentation and interpretation

Objective 1: To study the background of the institution with respect to the infrastructure

Table 1.1 illustrates the condition of the infrastructural facilities present in the visited schools. The findings indicate that both schools have an adequate number of classrooms with appropriate seating arrangements. Additionally, both schools offer facilities such as a dedicated headroom, library, and ample space for co-curricular activities within the school premises.

Table 1.2 presents the enrollment status of students benefiting from this school. It was observed that out of a total of 22 students benefiting from this school, 20 were residing as hostlers, while the remaining 2 students return to their homes after school hours. Furthermore, upon discussing this matter with the stakeholders, they reported that despite the school having 30 available seats; only 22 students were currently taking advantage of this opportunity, leaving 8 seats unoccupied. This shortage is attributed to a lack of awareness among the community, according to their feedback.

Table 1.3 provides an overview of the enrollment status of students benefiting from these schools. The data reveals that a total of 27 students are currently benefiting from this school. Out of this number, 24 students reside in the school hostel facilities, while the remaining 3 students return to their homes after completing their school activities. Furthermore, discussions with stakeholders shed light on the fact that although the school has a capacity to accommodate 30 students, only 27 students were currently taking advantage of its benefits, leaving 3 seats unoccupied. Stakeholders mentioned that a key reason for not using all these benefits because many people in the community do not have the information regarding this.

Table 1.4 provides an overview of the staff members employed in school (A). The data reveals that there were five teachers or instructors, one cook, one helper, one resource person, and one warden serving in this school, contributing to its operations. Furthermore, upon further investigation, it was discovered that this school does not have a superintendent, clerk, or peon to carry out non-teaching activities.



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Table 1.5 presents an overview of the staff members employed at school (B). The data indicates that the school employs four teachers or instructors, one Superintendent Grade II, one cook, one clerk, one helper, one security guard (chowkidar), one resource person, and one warden, all contributing to the functioning of the school. Additionally, as part of this study, the researcher observed that there was no peon employed at the school to handle non-teaching activities.

Table 1.6 provides an insight into the incentives provided to students in both visited schools. According to the school administration, these institutions offer a range of incentives to their students, including scholarships or stipends, midday meals, uniforms, textbooks, and stationary. These incentives were designed to ensure that the students have access to these essential resources and that their education was not hindered by a lack of these necessities.

Table 1.7 presents the various forms of assistance extended by the community to support these students. It was identified that the community offers support in the form of monetary assistance to enable students to purchase necessary items. The data in the table underscores the active role that the community plays in uplifting visually impaired students and addressing their educational challenges.

Objective 2: To study the educational problems of the visually impaired children

Table 2.1 illustrates the problems faced by students in schools A and B. In school A and school B, 13 out of 30 students (43%) reported facing issues related to their studies. Regarding hostel facilities 17 out of 30 students (56%) in both schools reported problems with the hostel facilities. 19 out of 30 students (63%) from both schools expressed difficulties in their relationships with teachers related student teacher relationship. It was observed that a significant number of students facing problem, specifically 20 out of 30 (66%), faced issues related to the availability of teaching and learning materials in both schools. These findings suggest that there were various challenges and concerns faced by the students in both schools, including problems with their studies, hostel facilities, student-teacher relationships, and the availability of teaching and learning materials.

Table 2.2 presents data showing that the majority of students were admitted to formal schools after the age of 8 years. The researcher was particularly interested in understanding the factors behind this late admission. The findings revealed that 63% of the students claimed that their parents were unaware of suitable schooling options for their impairment, while 30% attributed their late admission to a lack of interest in education. When students were asked about their satisfaction with the school, 83% reported being satisfied, while 16% expressed dissatisfaction. Furthermore, when students were questioned about their future plans, 6.6% expressed a desire to qualify for the 10th-grade examination, 13% aimed to complete the higher secondary stage, and a significant 80% indicated a desire to continue their education at the university level

Objective 3: To Assess the Views of the Principal, Teacher and Children Regarding the Functioning of the Schools

Table 2.3 provides details about the qualifications and special training of teachers in two different schools. The findings revealed that the majority of teachers were untrained in dealing with this particular type of students, meaning that they had not received the necessary training on how to effectively instruct and support such students.

Table 4.18 provides an insight into the adequacy of teaching materials in both institutions. The research findings indicate several noteworthy observations. In both institutions, there were shortages of electronic textbooks, which are essential for modern teaching methods. There is a noticeable absence of sufficient audio-video facilities, which play a crucial role in enhancing the learning experience for students. Lack of Braille machines hinders the educational accessibility for visually impaired students in both institutions. Neither institution provides facilities for digital text, which is increasingly important in the digital age. Furthermore, there is an absence of sensory table activities designed for the benefit of blind students in both schools. It was worth noting that the research also uncovered that School (A) boasts a well-maintained computer lab for its students, which is a valuable resource for



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their education. However, School (B) lacks a computer lab, indicating a disparity in technology resources between the two institutions.

Over All Findings and Results

- Both schools have sufficient well-arranged classrooms, along with essential facilities such as a headroom, library, and space for co-curricular activities.
- The student enrolment in the first school is 22, out of which 20 are hostellers, and 2 commute from home. Despite having 30 available seats, 8 seats remain vacant due to community awareness issues.
- In school B, 27 students benefit from its services, with 24 as hostellers and 3 commuting from home. Although 30 seats are available, 3 seats are vacant, primarily due to a lack of community awareness.
- In school (A) lacks a superintendent, clerk, and peon for non-teaching activities and in school (B) it was also found that there were no peon for non-teaching tasks.
- It was found that there were various types of problems faced by the students in these schools.
- 43% of students reported difficulties in reading, writing, and understanding concepts, while 16% had no study-related issues.
- 13% of students faced hostel-related challenges, such as adjustment and resource-sharing problems, but all had good relationships with their teachers.
- 23% experienced initial difficulties when teachers used new technology, which were resolved once they became familiar with it.
- Respondents' entry age into school varied significantly. 28% were admitted below the age of 6, 23% between 6-8 years, and 50% above 8 years. Most students entered formal schooling after the age of 8, prompting the researcher to investigate the reasons behind their late admission.
- The majority (63%) of students stated that their parents were unaware of suitable schooling options for their impairments, while 30% attributed their late admission to a lack of interest in education.
- When asked about their satisfaction with school, 83% of students reported being satisfied, while 16% were not.
- Regarding their future plans, 6.6% aspired to pass the 10th-grade examination, 13% aimed for higher secondary education, but a substantial 80% expressed their desire to pursue education at the university level.
- The findings revealed that the majority of teachers were untrained in dealing with this particular type of students, meaning that they had not received the necessary training on how to effectively instruct and support such students.
- In both institutions, it was observed that there was a shortage of electronic textbooks, insufficient audio-video facilities, and a lack of Braille machines, no digital text resources, and no sensory table activities for blind students.

Educational Implications

- The findings highlight the need for specialized training programs for teachers in residential schools to effectively support visually impaired students. These programs should focus on inclusive teaching methods, the use of assistive technologies, and strategies for addressing the unique needs of visually impaired students.
- It's crucial to invest in the development and provision of accessible learning materials, including electronic textbooks, audio-video resources, Braille machines, and digital texts. Schools should ensure that visually impaired students have access to the same educational resources as their sighted peers.
- Schools should address the lack of essential facilities such as sensory table activities for blind students. Additionally, schools should consider providing computer labs to enhance students' digital literacy and access to information.
- To overcome the issue of late admissions due to parental unawareness, there should be awareness campaigns to educate parents about the available schooling options for visually impaired students. This can help ensure that these students are enrolled in school at an appropriate age.
- The study suggests that curricula and teaching methods should be adapted to accommodate the specific needs of visually impaired students. This includes the use of tactile teaching materials and the incorporation of assistive technologies.





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- Residential schools should offer support services, including counselling and guidance, to help students overcome challenges related to late admissions, lack of interest in education, and other psychosocial factors that might affect their learning.
- Collaborating with organizations specializing in services for the visually impaired can be instrumental in addressing the challenges faced by these students. Such partnerships can provide access to expertise and resources.
- Inclusive and Equitable Education: The study underscores the importance of ensuring that visually impaired students have equal access to quality education. Schools and policymakers should work towards creating an inclusive and equitable education system that accommodates the diverse needs of all students
- Continued research in this area is vital to understanding the evolving needs of visually impaired students in residential schools. Regular data collection and evaluation can inform on-going improvements in the education system for these students
- The study's findings can serve as a foundation for advocating for policy changes that prioritize the educational needs and rights of visually impaired students, ensuring they have the support and resources necessary for their academic success.

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Table 1.1 Infrastructure facilities in school A and B

S.NO	INFRASTRUCTURE	School A	School B
		Yes/No	Yes/No
1	Sufficient Classroom	Yes	Yes
2	*Sitting arrangement	Yes	Yes
3	Principal/headroom	Yes	Yes
4	Library	Yes	Yes
5	*Space for co-curricular activity	Yes	Yes





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Table 1.2 Number of Students in the School (A)

S.no	Class	Total No.	Hostel Student	Day Scholars
1	I.	03	03	Nil
2	II.	02	01	01
3	III.	02	02	Nil
4	IV.	05	04	01
5	V.	02	02	Nil
6	VI.	Nil	Nil	Nil
7	VII.	02	02	Nil
8	VIII.	04	04	Nil
9	IX.	02	02	Nil
10	X.	Nil	Nil	Nil
	Total	22	20	2

Table 1.3 Numbers of students in school(B)

S.no	Class	Total no of students	Hostel student	Day schooling
1	I	02	02	Nil
2	II	06	05	01
3	III	02	02	Nil
4	IV	04	04	Nil
5	V	02	02	Nil
6	VI	02	01	01
7	VII	01	01	Nil
8	VIII	08	07	01
9	IX	Nil	Nil	Nil
10	X	Nil	Nil	Nil
	Total	27	24	3

Table 1.4 Staff Employed In School (A)

S.no	Staff	No.of staff members
1	Teacher/Instructor	5
2	Supdt.Gr-Ii	Nil
3	Clerk(S)	Nil
4	Cook	1
5	Helper	1
6	Cowkidar	1
7	Peon	Nil
8	Resource Person	1
9	Warden	1

Table 1.5 Staff Employed In School (B)

S. No	Staff	No. of staff members
1	Teacher/Instructor	4
2	Supdt.Gr-Ii	1
3	Clerk(S)	1
4	Cook	1





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5	Helper	1
6	Chowkidar	1
7	Peon	Nil
8	Resource Person	1
9	Warden	1

Table 4.6: Incentives available for the students in both schools

S.no	Incentives Available	School A	School B
		YES/NO	YES/NO
1	Scholarships/Stipends	Yes	Yes
2	Midday Meals	Yes	Yes
3	Uniforms	Yes	Yes
4	Textbooks	Yes	Yes
5	Stationary	Yes	Yes

Table 1.7 Help provided by community in School (A) and in school (B)

S.NO	Nature of Help	SCHOOL (A) YES/NO	SCHOOL(B) YES/NO
1	Cash Money To Students	Yes	No
2	Repair Building Of Needed	Yes	Yes
3	Money To Bring Needed Materials	Yes	Yes
4	Adoption Of Children	Yes	No
5	Material Like Furniture, Books, Dress Or Any Other	Yes	No

Table 2.1 Problems faced by the students in school (A) and (B)

S.no	Problems Related	Yes	%
1	Studies	13/30	43%
2	Hostel Facilities	17/30	56%
3	Student/ Teachers Relation	19/30	63%
4	Teaching Learning Material	20/30	66%

Table 2.2 Experiences of the students with the formal schooling

1	Reason For Late Admission	Lack Of Awareness		Did Not Get Entry		No Vacancy		Not Interested	
		19	63%	Nil	0%	2	7%	9	30%
2	Are You Satisfied With School	Yes				No			
		25		83%		5		16%	
3	Future Plan Related With Education	Up to 10 th		Upto12th				Higher Education	
		2	6.6%	4		13%		24	80%

Table 2.3 Profile of Teachers Available In School (A) And In School (B)

S.No	Name Of The Teacher	School	Qualification	Special Training Yes/No
1	T1	A	M.A B.ED	Yes
2	T2	A	Graduation	No





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3	T3	A	MA, B.ED	Yes
4	T4	A	M.A	No
5	T5	B	BA, BED	No
6	T6	B	B.A	No
7	T7	B	10+2	No
8	T8	B	M.A	No

Table 2.4 Adequacy of Teaching /Learning Materials in school (A) and (B)

S.No	Items	School(A)		School(B)	
		Yes	No	Yes	No
1	Electronic Textbooks		✓		✓
2	Proper Audio Video Facilities		✓		✓
3	Lack Of Braille Machines	✓		✓	
4	Facilities Of Digital Text		✓		✓
6	Computer Lab	✓			





Brain Tumor Detection from MRI Images using Hybrid deep Convolution Neural Network (HDCNN)

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ABSTRACT

Brain tumors are indeed a serious and potentially life-threatening form of cancer that can affect both adults and children. These tumors can arise from various types of cells within the brain and can cause a range of symptoms depending on their location and size. Convolutional Neural Networks (CNNs) have demonstrated remarkable performance in computer vision tasks such as image segmentation and classification. However, training CNNs can be computationally intensive, leading to longer processing times. This paper focuses on diagnosing brain tumors utilizing MRI images, employing hybrid Deep CNN models (HDCNN), a type of deep learning network, for the diagnostic procedure. The performance evaluation of a hybrid deep Convolutional Neural Network (HDCNN) utilized for detecting brain tumors in 2D magnetic resonance brain images is discussed in our study. We proposed a CNN architecture combined with deep learning techniques for segmenting brain tumors in MRI scans. Our research demonstrates that the hybrid deep CNN achieved an outstanding accuracy of 98.42%, surpassing previous results in this domain. This high accuracy is crucial for ensuring reliable diagnoses and effective treatment planning in medical imaging tasks. The success of our model underscores the potential of deep learning techniques in medical image analysis and holds promise for improving patient outcomes through early and accurate tumor detection.

Keywords - Machine Learning, Brain tumor, CNN, MRI.



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INTRODUCTION

The brain plays a central role in the human body, governing the functions of all other organs and facilitating decision-making [1]. The study described in this publication focuses on identifying the health status of the brain, employing deep learning methodologies. Specifically, a hybrid CNN approach was utilized to distinguish between healthy and injured brains by classifying them into categories of either normal or containing tumors [10]. Artificial neural networks (ANNs) mimic the intricate structure and functionality of the human nervous system, comprising interconnected nodes that process information. These networks learn from training data by adjusting connection weights and store learned patterns. In ANNs, activation functions are applied to input features and hidden layers to produce the desired output. Convolutional neural networks (CNNs) are particularly effective in medical imaging, offering non-invasive techniques for internal body examination [1]. The main utility of artificial neural networks (ANNs) in the human body lies in therapeutic and diagnostic applications, profoundly impacting treatment efficacy and overall health outcomes. Image processing at an advanced level heavily relies on the critical task of picture segmentation [2]. In our research, particular emphasis has been placed on isolating brain tumors from MRI scans, aiding medical practitioners in precisely locating tumors within the brain. Our introduced model achieved a remarkable accuracy of 98.42%, exceeding current state-of-the-art results.

LITERATURE REVIEW

According to IsselmouAbd El Kader (2021), deep wavelet auto-encoder model has the capacity to detect and categorise the tumour with high accuracy, quick turnaround, and little loss validation by analysing the pixel pattern of an MR brain picture. In order to detect the presence of brain tumours, P GokilaBrindha (2021) suggested a self-defined Artificial Neural Network (ANN) and Convolution Neural Network (CNN), and their effectiveness is evaluated. Using a convolutional neural network, ArkapravoChattopadhyay (2022) devised an approach to segment brain tumours from 2D MRI images of the brain. proposed technique using "Python" and "TensorFlow" with "Keras". An innovative method for detecting brain tumours is proposed by HareemKibriya (2023) using a collection of deep and manually built feature vectors (FV). The distinctive FV combines sophisticated VGG16-based features with manually produced GLCM-based features. (grey level co-occurrence matrix). Using brain magnetic resonance imaging (MRI), Debnath Bhattacharyya (2011) proposes an image segmentation technique to identify or detect tumours. a series of image segmentation algorithms that produce excellent results when applied to images of brain tumours are proposed. (2020) Md. Ariful Islam For organising input-output data, a graphical user interface has been employed, and an algorithm has been created.

METHODOLOGY

To apply a hybrid deep Convolutional Neural Network (CNN) to the detection of brain tumors, several steps are typically involved:

Data Collection and Preprocessing

Gather a dataset of 2D magnetic resonance brain images containing both images with tumors and normal brain images. Preprocess the images to ensure consistency and quality, including resizing, normalization, and possibly augmentation to increase the diversity of the dataset.

Data Labeling

Annotate the images to mark the regions containing tumors. This step is crucial for supervised learning, where the CNN learns from labeled examples.



**Anu Sharma et al.,****Model Architecture Design**

Design a hybrid deep CNN architecture that combines different types of layers, such as convolutional layers, pooling layers, and possibly other types of layers like recurrent or attention mechanisms. Determine the depth and complexity of the network, considering computational resources and the complexity of the task.

Model Training

Split the dataset into training, validation, and test sets. Train the hybrid CNN model using the training data, adjusting the network's parameters to minimize the loss function. Validate the model's performance using the validation set to monitor for overfitting and fine-tune hyperparameters as necessary.

Evaluation

Evaluate the trained model's performance using the test set, measuring metrics such as accuracy, precision, recall, and F1-score. Compare the model's performance against existing methods or benchmarks to assess its effectiveness. Once the model achieves satisfactory performance, deploy it for practical use in detecting brain tumors in new MRI scans. Monitor the model's performance in real-world scenarios and periodically update it with new data or improvements as needed.

Data set

To create a hybrid deep Convolutional Neural Network (CNN) for the detection of brain tumors, we first need a dataset consisting of 2D magnetic resonance brain images. Training, validation, and testing datasets are separated from the image dataset.

IMPLEMENTATION AND RESULTS

When developing automated systems, it's crucial to effectively evaluate the model's performance. Assessing both the training and test sets demonstrates the system's generalization capabilities. The confusion matrix (CM), a simple cross-tabulation of actual and classified data for each class, is a widely used technique for evaluating classification models. Various classification measures derived from the CM were employed to evaluate the model's performance in this study. The F1-score, which combines recall and precision into a single metric, is particularly valuable, especially in cases of data imbalance. The study's criteria, including precision, recall, accuracy, and, are defined in Equations (1)–(4), respectively.

$$\text{Precision} = \text{TP} / (\text{TP} + \text{FP}) \quad (1)$$

$$\text{Recall} = \text{TP} / (\text{TP} + \text{FN}) \quad (2)$$

$$\text{Accuracy} = (\text{TP} + \text{TN}) / (\text{TP} + \text{TN} + \text{FP} + \text{FN}) \quad (3)$$

$$\text{F1-Score} = (\text{TP}) / (\text{TP} + 1/2(\text{FP} + \text{FN})) \quad (4)$$

According to Table 3, Seetha et al, Tonmoy Hossain et al and Badza et al. acquired the state-of-the-art findings, and our suggested model Hybrid Deep CNN outperformed them with an accuracy rate of 98.42% as shown in figure 5.

CONCLUSION

The hybrid CNN model (HDCNN) developed for brain tumor detection demonstrates exceptional performance, achieving a remarkable accuracy of 98.42%. The success of our hybrid deep CNN model holds significant implications for medical imaging and healthcare. By accurately identifying brain tumors from MRI scans, our model assists medical professionals in diagnosing and treating patients more effectively.

Moving forward, we aim to further refine our model and explore its applicability to other medical imaging tasks. Additionally, ongoing research and collaboration with domain experts will ensure the continued improvement and real-world deployment of our hybrid deep CNN model for the benefit of patients and healthcare providers alike.





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Table 1: Contrasting models

Final Layer Activation Method	Accuracy (%)	Testing Accuracy (%)	Evaluation of the Model (%)
SVM	13.14	21.43	21.17
Sigmoid	94.62	57.34	68.62
Softmax	98.36	93.32	94.82

Table 2.:Performance of the Hybrid Deep CNN model.

	Training Image	Testing Image	Splitting Ratio	Accuracy (%)
1	2293	547	8:1	98.41
2	2564	278	9:1	98.38

Table 3. Performance Comparison.

Methodology	Accuracy (%)
Seetha	97.50
Tonmoy et al.	97.87
Badza et.al	96.56%
Hybrid Deep CNN model	98.42

Table 4: FPR and FNR values

Model	FPR	FNR
Google-Net	0.714	0.339
Multimodal	-	1.74
KNN	0.62	0.54
Hybrid Deep CNN model	0.0625	0.031

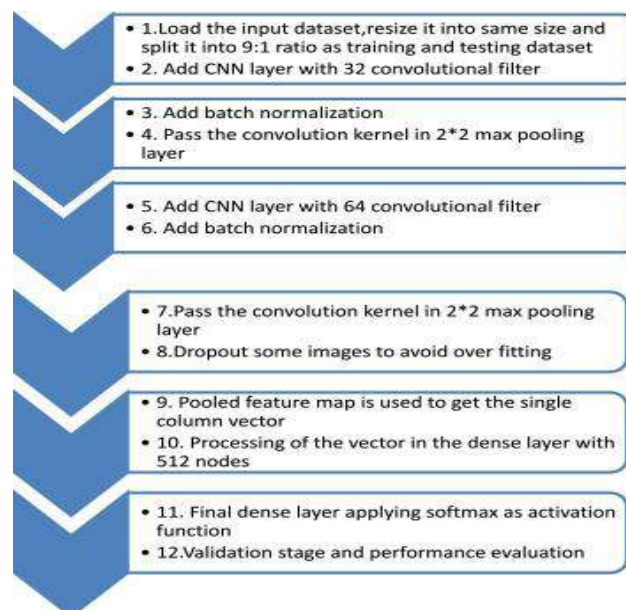


Fig 1: Workflow of the proposed HDCNN model.





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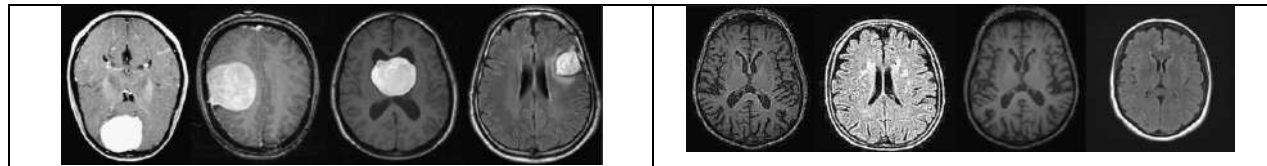


Fig 2: Tumours. Images

Fig 3: Non-Tumours Images

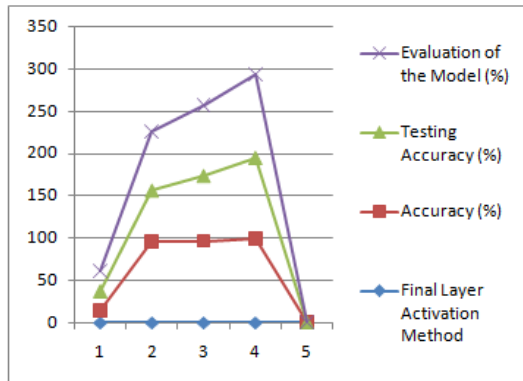


Fig 4: Comparison of different models.

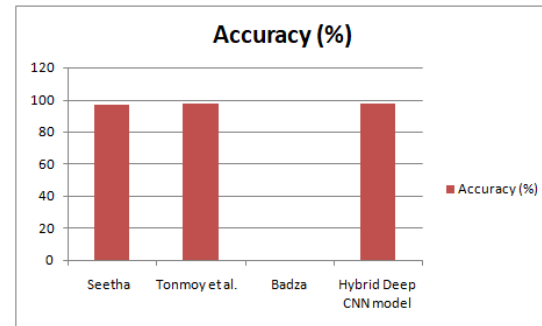


Fig 5: Performance comparison.

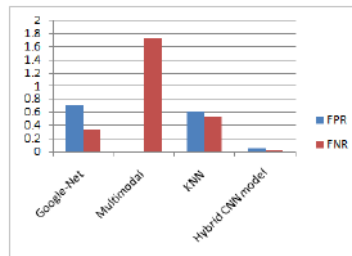


Fig 6: FPR and FNR





De Novo Regeneration from *In vitro* Leaves of Ethnomedicinal Plant *Peganum harmala*

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ABSTRACT

Ethnomedicinal plant *Peganum harmala* containing huge amount of valuable metabolites, those are responsible to treat variety of diseases. To serve this purpose, it is an alarming need to conserve this precious endangered herb. Plant regeneration from leaves of *Peganum harmala* was made possible by supplement of optimum hormonal concentrations and at appropriate invitro conditions. Multiple shoot regeneration from *Peganum harmala* (L) was obtained with different hormonal concentrations, auxin; α -Naphthalene acetic acid (NAA) 0.5 to 3 mg/l and cytokinin; Benzyl amino purine (BAP) 0.5 to 4mg/l. Induction of roots was obtained by hormone α -Naphthalene acetic acid at concentration 0.5 to 2.5mg/l. Among the different concentrations of plant growth regulators, direct shoot induction (DSI) from *Peganum harmala* (L) was best carried out by α -Naphthalene acetic acid (1mg/l) in combination with Benzyl amino purine (2.5mg/l). Best results concerning induction of roots were obtained by α -Naphthalene acetic acid (2.5mg/l) without any cytokinin, while auxin; Indole-3-butyric acid (IBA) was unresponsive for inducing roots.

Keywords: plant growth regulators, plant regeneration, shoots, roots, field transfer

INTRODUCTION

Peganum harmala is highly medicinal herbaceous perennial plant with deep roots and native to North Africa, Middle East, India, Pakistan and Iran. This plant belongs to nitrariaceae family and commonly known as Syrian rue/ wild rue. This ethnomedicinal plant is indigenous to India; possess therapeutic benefits. (1) In sanskrit, it is known as *soma*. It has been widely used in ayurvedic medicine of rigveda specified by *Brahma-Manu*.(1) This branched herb grows from 30 to 60 cm in length arranged with narrow leaves and stiff stem.(2) Flowers are five petaled structure,



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yellowish white in colour with an unpleasant odour. Fruits are three chambered capsules containing blackish brown seeds of triangular with small size.(2) Secondary metabolites such as; harmine, harmaline, harmalol make this plant more valuable.(3). Local tribal communities used this plant in treatment of various ailments such as; piles, measles, stomach complaints, menstrual problems, mental illness, sexual disorders etc.(1) Ethnomedicinal properties make this plant unique and economically important and hence it is required more propagation of this precious herb. As per the climatic changes, environmental conditions are also changing and hence the plant systems of particular area are dying due to unfavorable conditions. They are at the edge of extinction. Plant such as *Peganum harmala* containing highly medicinal value is disappearing from the study area. So it is an urgent need to conserve it and propagate in laboratories. Many propagation protocols have been applied for invitro regeneration of *Peganum harmala*. Callus culture was obtained from invitro seedling explants.(4) Invitro multiple shoot regeneration was obtained from cotyledon culture. (5) Invitro shoot regeneration from shoot apices was studied (6) and many other propagation designs are applied. Recently multiple shoots and callus induction from leaves of *Peganum harmala* were obtained.(7) This research study concentrate on denovo regeneration or adventitious regeneration of whole plant from leaves of *Peganum harmala* in region of Shekhawati, Rajasthan.

MATERIAL AND METHODS**Media preparation**

Murashige and skoog nutrient medium(8) was prepared and pH was adjusted to 5.8. Prepared medium was autoclaved at 121⁰ c and 15 psi for 15 minutes.

Invitro germination of seeds of *Peganum harmala*

Peganum harmala seeds were collected and proceeded for surface sterilization in laminar air flow. Firstly seeds were washed with teepol solution for -4 minutes and then washed with autoclaved distilled water (2 times). The seeds were immersed in 10% NaOCl solution for 4-5 minutes and then again washed with autoclaved distilled water (3-4 times). The seeds were taken on sterile whatman filter paper so that excess water was soaked. Surface sterilized seeds were inoculated on MS medium with no hormonal concentrations and kept in culture room at 25⁰ c \pm 2, 16 photoperiod light.

Direct shoot induction from leaves of *Peganum harmala*

Leaf segments (5-10mm) were excised from invitro germinated seeds and served as explants for direct shoot induction. Leaf explants were cultured on MS medium containing different concentrations of auxin and cytokinin. Five combinations of auxin and cytokinin are shown in table 1.

Rooting culture for regenerated shoots from leaves of *Peganum harmala*

Regenerated shoots were aseptically transferred to rooting medium containing MS medium components and rooting hormones. Different combinations of rooting hormones (auxin and cytokinin) are shown in table 2.

Acclimatization and field transfer

Regenerated plantlets from invitro leaf explants of *Peganum harmala* were proceeded for acclimatization in natural environmental conditions. Invitro plantlets were kept in plastic cups containing sterile soil and transferred to culture chamber for 1-2 weeks (Sometimes plantlets start to degrade, so we can spray half concentration of MS medium without agar to the sterile soil) After 1-2 weeks, acclimatized plantlets were transfer to field in natural environmental conditions.





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RESULT AND DISCUSSION

Seeds of *Peganum harmala* showed 75-80% efficacy to germinate on MS solid medium within one week. 5 different combinations of NAA and BAP were examined for direct shoot induction from invitro leaves of *Peganum harmala*. Various no. of shoots were regenerated, shown in table 3. 20 different combinations of NAA, BAP and IBA were used for rooting purpose, shown in table 4. Medium containing NAA alone was having capability to induce roots. Medium containing BAP with NAA and IBA were able to induce callus while medium containing IBA alone was unresponsive. Regeneration of plants in invitro condition depends upon factors such as; light, temperature and concentration of hormones. If concentration of plant growth regulators is extreme high or low then plant growth would be inhibited. Every plant has its own optimum condition to grow. It was estimated from the results that *Peganum harmala* best grow at temperature 25 ± 2 , 16 h light and 8 h dark. Combination of NAA (1mg/l) and BAP (2.5mg/l) found to have major capability to induce shoots. While NAA (2.5mg/l) without cytokinin was able to induce roots. Survival rate of invitro plantlets in natural environment was observed with 40-50% of efficacy.

CONCLUSION

Peganum harmala is precious ethnomedicinal herb used to treat various ailments such as; mental disorders, lice problems, asthma, menstrual problems etc. In study area of Shekhawati region this valuable plant is at the edge of extinction due to over exploitation, anthropogenic activities and unawareness of its medicinal value. So it is an urgent need to conserve this precious herb via micro propagation techniques. From the study it is concluded that *Peganum harmala* can be regenerated in invitro condition by supplementing optimum hormone concentrations of NAA and BAP. Invitro explants of the herb played key role in the experiment. Invivo explants (leaves) were also used to regenerate the plantlets of *Peganum harmala* but unresponsive results (no shoots and no callus formation) were found.

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CONFLICT OF INTEREST

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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Table 1: Different combinations of hormones for direct shoot induction

MS Medium	Plant growth regulators concentration (mg/l)	
Sr. No.	NAA	BAP
1.	0.5	1.5
2.	0.5	3
3.	1	2.5
4.	1	3.5
5.	1.5	4
6.	0.5	0.5
7.	1	1
8.	1	1.5
9.	2	2.5
10.	3	3.5

NAA (α -Naphthalene acetic acid), BAP (Benzyl amino purine)

Table 2: Different combinations of hormones for rooting from shoots

MS Medium	Plant growth regulators concentration (mg/l)		
Sr. No.	NAA	BAP	IBA
1.	0.5	0	0
2.	1	0	0
3.	1.5	0	0
4.	2	0	0
5.	2.5	0	0
6.	0	0	0.5
7.	0	0	1
8.	0	0	1.5
9.	0	0	2
10.	0	0	2.5
11.	0.5	0.5	0
12.	1	0.5	0
13.	1.5	0.5	0
14.	2	0.5	0
15.	2.5	0.5	0
16.	0	0.5	0.5
17.	0	0.5	1
18.	0	0.5	1.5
19.	0	0.5	2
20.	0	0.5	2.5

IBA (Indole-3-butyric acid)



**Table: 3 Induction of shoots in medium containing NAA and BAP**

MS Medium	Plant growth regulators concentration (mg/l)		Shoot induction	No. of shoots per explant
Sr. No.	NAA	BAP		
1.	0.5	1.5	+	10-15
2.	0.5	3	+	4-6
3.	1	2.5	+	18-25
4.	1	3.5	+	2-4
5.	1.5	4	+	3-5
6.	0.5	0.5	-	Callus
7.	1	1	-	Callus
8.	1	1.5	-	Callus
9.	2	2.5	-	Callus
10.	3	3.5	-	Callus

+ (formation of shoots), - (unresponsive)

Table: 4 Effect of different combinations of plant growth regulators on root induction

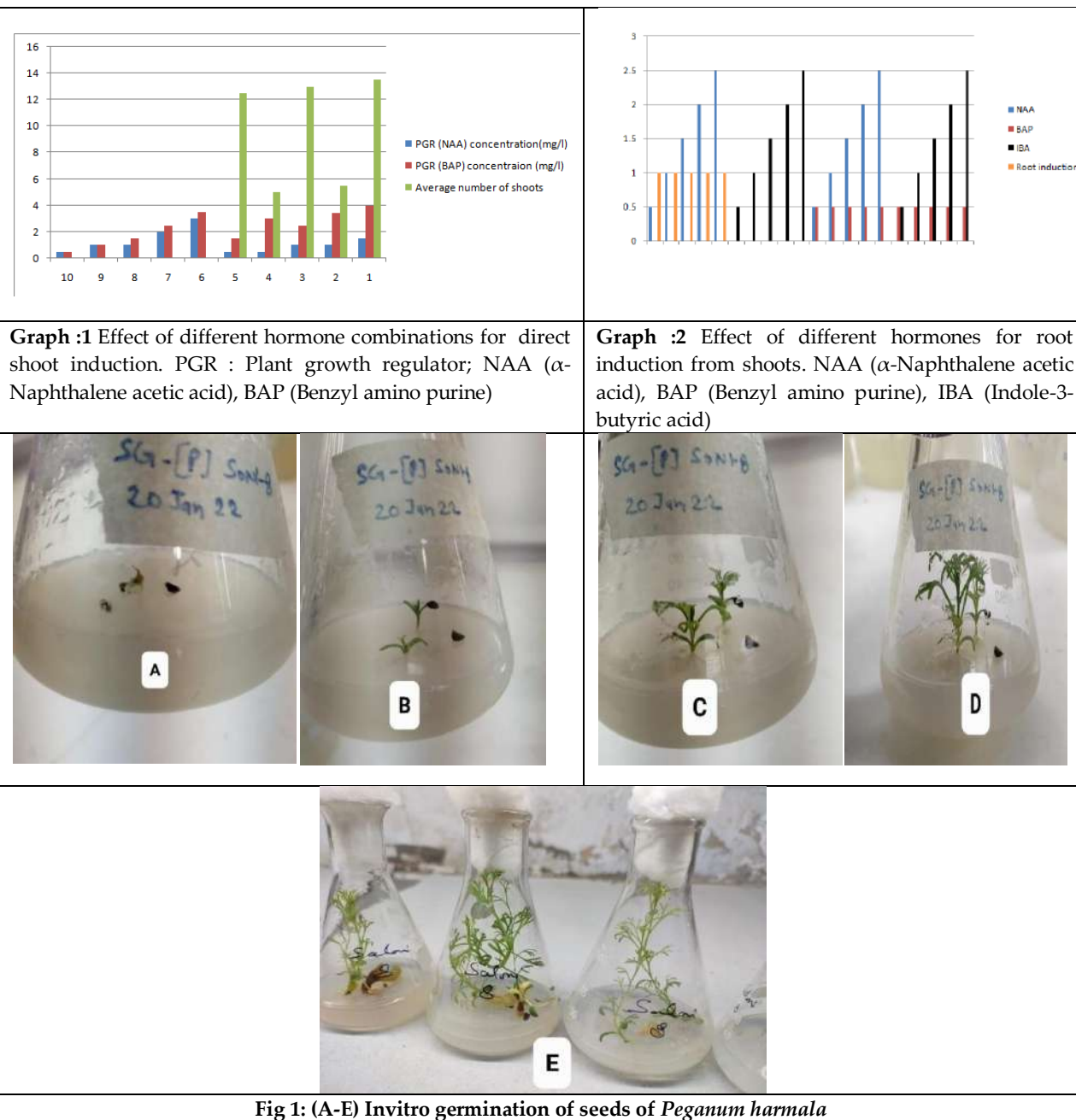
MS Medium	Plant growth regulators concentration (mg/l)				
Sr. No.	NAA	BAP	Root induction	IBA	Root induction
1.	0.5	0	+	0	
2.	1	0	+	0	
3.	1.5	0	+	0	
4.	2	0	+	0	
5.	2.5	0	+	0	
6.	0	0		0.5	-
7.	0	0		1	-
8.	0	0		1.5	-
9.	0	0		2	-
10.	0	0		2.5	-
11.	0.5	0.5	Callus	0	
12.	1	0.5	Callus	0	
13.	1.5	0.5	Callus	0	
14.	2	0.5	Callus	0	
15.	2.5	0.5	Callus	0	
16.	0	0.5		0.5	-
17.	0	0.5		1	-
18.	0	0.5		1.5	-
19.	0	0.5		2	-
20.	0	0.5		2.5	-

+ (formation of roots), - (unresponsive)





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Fig 2: (M-1 to M-5) Induction of shoots at different concentrations of NAA and BAP

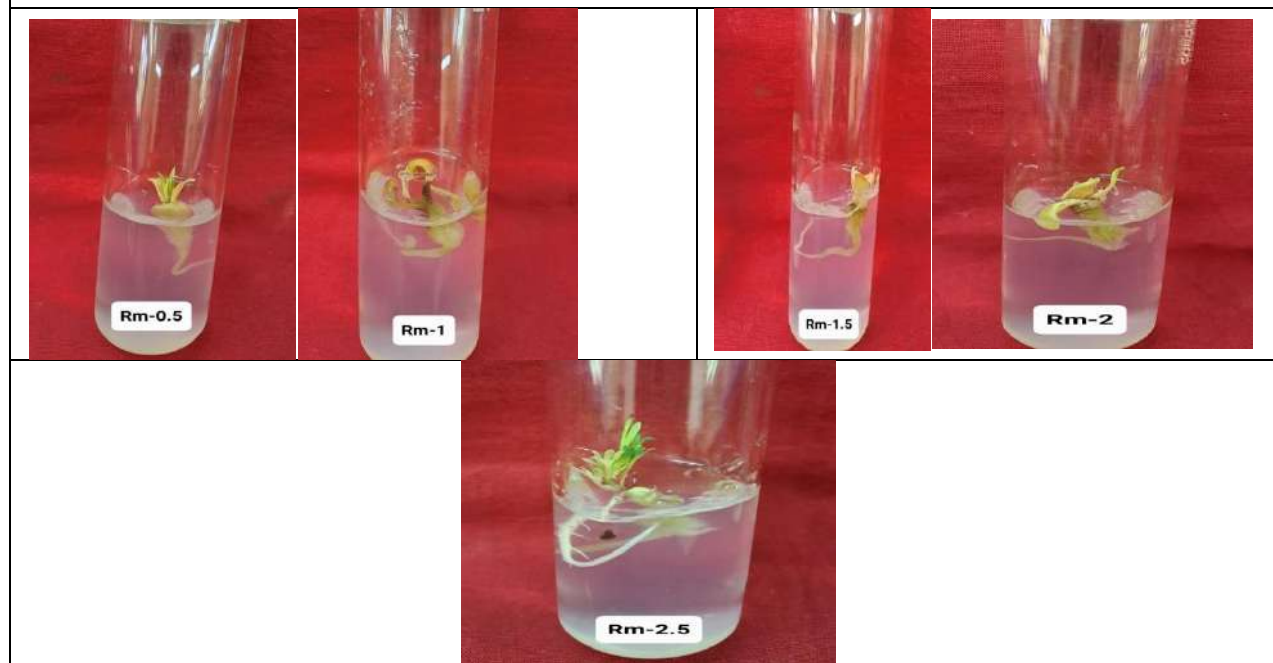


Fig 3: (Rm 0.5 to 2.5) Induction of roots in rooting medium containing NAA





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Fig 4: (A-B) Field transfer of *in vitro* regenerated plantlets of *Peganum harmala*





Extended Conjugate Gradient FR Approach for Solving Unconstrained Fuzzy Optimization Problem

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ABSTRACT

For solving non-linear fuzzy optimization problems, a technique based on numerical optimization using Hukuhara differentiability for fuzzy-valued functions used in this approach. The strategies deal with the problem of nonlinear unconstrained optimization in fuzzy nature. This proposed method having the origin of the Conjugate Gradient FR approach and enhanced the algorithm to find the solution for an unrestricted multi-variable fuzzy optimization problem. The optimal solution is reached by this method follows a series of steps and the rate of convergence is faster than the methods in literature. The number of iterations is considerably reduced even though it contains fuzzy numbers. The proposed algorithmic approach is described clearly and illustrations are very much useful to understand the proposed method.

Keywords: Conjugate Gradient Technique, Algorithms, Fuzzy Nonlinear Equations, Fuzzy Triangular Numbers, Numerical Techniques, Optimization Technique, Fuzzy interval and Ranking.





INTRODUCTION

Optimizing errands in a fuzzy condition can significantly advantage from the application of fuzzy optimization techniques. The objective or aim is to optimize the fuzzy function with multivariable. Some of the authors used numerous methods like Steepest descent, Newton method, Quasi newton, etc to optimize. They have conferred uncertainty fuzzy programming models for multi-objective shortest way problem with complex parameters. Such optimization techniques are applied to deal with real life problems. The approaches for finding the most brilliant potential results under many different circumstances might be called optimization. In common the proper decision making or optimization approach constitute an idea or an algorithmic approach.

Zadeh in 1965 introduced the fuzzy concept play vital role to deal with variabilities and to reflect the real-life world situations.[1]Bellman and Zadeh was proposed decision making in fuzzy environment[2]. The gradient method for finding the solution of unconstrained optimization was proposed by Umamaheswari and Ganesan.[20] The Newton's method for finding the solutions of unconstrained problems and generalized Hukuhara differentiability of fuzzy valued functions were considered by Pirzada and Pathak [3-7]. The derivative approach on fuzzy differential equations were used in many literatures to solve fuzzy LPP and fuzzy NLP problems.[8-13] Conjugate Gradient FR (CG-FR) Method was introduced by M. R. Hestenes and E. Stiefel in 1952 is one of the most general iterative aspect methods for solving large systems of linear equations.

In this paper, the numerical optimization technique is proposed for solving non-linear fuzzy optimization problems. In this approach, the detailed approach is given for the ordering of fuzzy triangular numbers and the applications of Hukuhara differentiability to fuzzy-valued functions. Here, the strategies deal with the optimizing the problem of nonlinear unconstrained optimization issue in fuzzy factors. It proposes the Conjugate Gradient FR approach to enhance the solution for an unrestricted multi-variable fuzzy optimization problem. [15-16]. The optimal solution is reached by the Conjugate Gradient FR method through a series of steps and the rate of convergence is faster when compared with rate of convergence of Newton's method[19-20]. The number of iterations is drastically reduced even though the numbers are in fuzzy. In this paper, the algorithmic approach is explained evidently and illustrations are given for better understanding of the proposed method.

Algorithm: Extended Conjugate Gradient FR Method

Step 1: Convert the unconstrained triangular fuzzy number function into two functions

$$\text{TFNL}, \tilde{a}_\alpha = [\tilde{a}_\alpha^L, \tilde{a}_\alpha^U] \text{ and } \text{TFNU}, \tilde{b}_\alpha = [\tilde{b}_\alpha^L, \tilde{b}_\alpha^U] [17]$$

Using The α - level of \tilde{a} is given by $\tilde{a} = [(1-\alpha)a^L + \alpha a, (1-\alpha)a^U + \alpha a] [14]$

Step 2:

$$\text{Find } \nabla f = \begin{bmatrix} \frac{\partial f}{\partial x_1} \\ \frac{\partial f}{\partial x_2} \end{bmatrix} \text{ and } \nabla^2 f = \begin{bmatrix} \frac{\partial^2 f}{\partial x_1^2} & \frac{\partial^2 f}{\partial x_1 \partial x_2} \\ \frac{\partial^2 f}{\partial x_2 \partial x_1} & \frac{\partial^2 f}{\partial x_2^2} \end{bmatrix}$$

Step 3:

Find the search direction S_i

$$S_i = -\nabla f_i + \beta_i S_{i-1}$$

$$\text{where } \beta_i = \frac{|\nabla f_i|^2}{|\nabla f_{i-1}|^2}$$





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Step 4: Determine $\lambda_i = \frac{\nabla f_i^T \nabla f}{S_i^T H S_i}$ and set $X_{i+1} = X_i + \lambda_i S_i$

Step 5: Ranking function $R(\bar{A}) = \frac{(a+b+c)}{3}$

Step 6: Test the optimality for the new point X_{i+1}

Numerical examples

Problem 3.1 Consider the Non-linear unconstrained fuzzy optimization problem Minimize $\tilde{f}(x) = (\tilde{1} \otimes x_1^3) \oplus (\tilde{2} \otimes x_2^3) \oplus (\tilde{1} \otimes x_1 x_2)$, $x_1, x_2 \in R$ where $\tilde{1} = (-1, 1, 3)$, $\tilde{2} = (1, 2, 3)$ are triangular fuzzy numbers and initial approximation for minimizer is $\bar{x}^{-0} = (1, 1)$

Using fuzzy arithmetic's, write $\tilde{f}(x_1, x_2) = (-1, 1, 3)x_1^3 + (1, 2, 3)x_2^3 + (-1, 1, 3)x_1 x_2$

$$\tilde{f}_\alpha^L(x_1, x_2) = (-1 + 2\alpha)x_1^3 + (1 + \alpha)x_2^3 + (-1 + 2\alpha)(x_1, x_2)$$

$$\tilde{f}_\alpha^U(x_1, x_2) = (3 - 2\alpha)x_1^3 + (3 - \alpha)x_2^3 + (3 - 2\alpha)(x_1, x_2).$$

Now, calculate sequence of non-dominated solutions $\{\bar{x}_k\}, k = 1, 2, \dots$ using the following equation:

$$X_{i+1} = X_i + \lambda_i S_i$$

$$\nabla F(\bar{X}) = \begin{pmatrix} 6x_1^2 + 2x_2 \\ 12x_2^2 + 2x_1 \end{pmatrix}$$

$$\nabla^2 F(\bar{X}) = \begin{pmatrix} 12x_1 & 2 \\ 2 & 24x_2 \end{pmatrix} \text{ At } \bar{x}^{-0} = (1, 1)$$

The solution of given problem is $\bar{x}^* = (0.196, -0.067)^T$ with accuracy 10^{-3} .

Problem 3.2 Consider the Non-linear unconstrained fuzzy optimization problem Minimize $\tilde{f}(x_1, x_2) = (-1, 1, 3)x_1^2 + (0, 1, 2)x_1 x_2 + (1, 2, 4)x_2^2$ and Initial approximation for minimizer is $\bar{x}^{-0} = (2, -2)$ where $x_1, x_2 \in R$

Using fuzzy arithmetic's, write $\tilde{f}(x_1, x_2) = (-1, 1, 3)x_1^2 + (0, 1, 2)x_1 x_2 + (1, 2, 4)x_2^2$

$$\tilde{f}_\alpha^L(x_1, x_2) = (-1 + 2\alpha)x_1^2 + \alpha(x_1 x_2) + (1 + \alpha)x_2^2$$

$$\tilde{f}_\alpha^U(x_1, x_2) = (3 - 2\alpha)x_1^2 + (2 - \alpha)(x_1 x_2) + (4 - 2\alpha)x_2^2$$

Compute sequence of non-dominated solutions $\{\bar{x}_k\}, k = 1, 2, \dots$ using the following equation:

$$X_{i+1} = X_i + \lambda_i S_i$$

$$\nabla F(\bar{X}) = \begin{pmatrix} 4x_1 + 2x_2 \\ 2x_1 + 9x_2 \end{pmatrix}$$

$$\nabla^2 F(\bar{X}) = \begin{pmatrix} 4 & 2 \\ 2 & 9 \end{pmatrix} \text{ At } \bar{x}^{-0} = (2, -2)$$

The solution is given by $\bar{x}^* = (1.47, -0.14)^T$ with accuracy 10^{-3} .





Problem3.3 Consider the Non-linear unconstrained fuzzy optimization problem.

Minimize $\tilde{f}(x_1, x_2) = (-1, 1, 3)x_1^2 + (0, 1, 2)x_1, x_2 + (1, 2, 4)x_2^2$ and the Initial approximation for minimizer is $\bar{x}^{-0} = (1, 1)$ where $x_1, x_2 \in R$.

Using fuzzy arithmetic's, write $\tilde{f}(x_1, x_2) = (-1, 1, 3)x_1^2 + (0, 1, 2)x_1, x_2 + (1, 2, 4)x_2^2$

$$\tilde{f}_\alpha^L(x_1, x_2) = (-1 + 2\alpha)x_1^2 + \alpha(x_1, x_2) + (1 + \alpha)x_2^2$$

$$\tilde{f}_\alpha^U(x_1, x_2) = (3 - 2\alpha)x_1^2 + (2 - \alpha)(x_1, x_2) + (4 - 2\alpha)x_2^2$$

Compute the sequence of non-dominated solutions $\{\bar{x}_k\}, k = 1, 2, \dots$ using the following equation:

$$X_{i+1} = X_i + \lambda_i S_i$$

$$\nabla F(\bar{X}) = \begin{pmatrix} 4x_1 + 2x_2 \\ 2x_1 + 9x_2 \end{pmatrix}$$

$$\nabla^2 F(\bar{X}) = \begin{pmatrix} 4 & 2 \\ 2 & 9 \end{pmatrix} \text{ At } \bar{x}^{-0} = (1, 1)$$

The solution is given by $\bar{x}^{-*} = (-0.00, 0.00)^T$ with accuracy 10^{-3} is attained.

Problem3.4 Consider Non-linear unconstrained fuzzy optimization problem Minimize

$\tilde{f}(x) = (\tilde{2} \otimes x_1^3) \oplus (\tilde{2} \otimes x_2^3) \oplus (\tilde{3} \otimes x_1, x_2), x_1, x_2 \in R$ where $\tilde{2} = (1, 2, 4), \tilde{3} = (1, 3, 5)$ are triangular fuzzy

numbers and initial approximation for minimizer is $\bar{x}^{-0} = (1, 1)$ Using fuzzy arithmetic's, write

$$\tilde{f}(x_1, x_2) = (1, 2, 4)x_1^3 + (1, 3, 5)x_1, x_2 + (1, 2, 4)x_2^3$$

$$\nabla F(\bar{x}) = \begin{pmatrix} 27 \frac{x_1^2}{2} \\ 27 \frac{x_2^2}{2} \end{pmatrix}, \nabla^2 F(\bar{X}) = \begin{pmatrix} 27x_1 & 0 \\ 0 & 27x_2 \end{pmatrix}$$

At $\bar{x}^{-0} = (1, 1)$ The solution is given by $\bar{x}^{-*} = (0.41, 0.41)^T$ with accuracy 10^{-3} .

Thus, the method has converged in six iterations for this fuzzy-valued function.

Problem	Iterations Required in Newton's method [7]	Proposed Fuzzy CG FR method
1	11	5
2	6	2
3	6	3
4	10	6

CONCLUSION

A well-known Conjugate Gradient FR method for solving a crisp multi-variable unconstrained fuzzy optimization problem is successfully extended to solve a multi-variable fuzzy unconstrained fuzzy optimization problem. The





convergence of the method proved the accuracy of the algorithm introduced in this paper. Appropriate illustrations are given to justify the proposed method.

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Tabulation1 : Convergence of Conjugate Gradient FR method

K	\bar{X}^K	β	s	λ	X_{k+1}	∇F_{K+1}	$\tilde{f}(x_1, x_2)$	$R(\tilde{A})$
0	(1,1)	-	$\begin{pmatrix} -8 \\ 14 \end{pmatrix}$	0.04392	$\begin{pmatrix} 0.64864 \\ 0.38512 \end{pmatrix}$	$\begin{pmatrix} 3.29464 \\ 3.07709 \end{pmatrix}$	$\begin{pmatrix} -0.46558 \\ 0.63694 \\ 1.73946 \end{pmatrix}$	0.63694





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1	$\begin{pmatrix} 0.64864 \\ 0.38512 \end{pmatrix}$	0.07788	$\begin{pmatrix} -3.91304 \\ -4.16032 \end{pmatrix}$	0.05886	$\begin{pmatrix} 0.41832 \\ 0.14024 \end{pmatrix}$	$\begin{pmatrix} 1.33043 \\ 1.07625 \end{pmatrix}$	$\begin{pmatrix} -0.12911 \\ 0.13739 \\ 0.40389 \end{pmatrix}$	0.13739
2	$\begin{pmatrix} 0.41832 \\ 0.14024 \end{pmatrix}$	0.14390	$\begin{pmatrix} -1.89309 \\ -4.16032 \end{pmatrix}$	0.07329	$\begin{pmatrix} 0.27958 \\ 0.01794 \end{pmatrix}$	$\begin{pmatrix} 0.50487 \\ 0.56302 \end{pmatrix}$	$\begin{pmatrix} -0.02686 \\ 0.02689 \\ 0.08064 \end{pmatrix}$	0.02689
3	$\begin{pmatrix} 0.27958 \\ 0.01794 \end{pmatrix}$	0.19342	$\begin{pmatrix} -0.86616 \\ -0.88275 \end{pmatrix}$	0.09647	$\begin{pmatrix} 0.19602 \\ -0.06722 \end{pmatrix}$	$\begin{pmatrix} 0.09610 \\ 0.44626 \end{pmatrix}$	$\begin{pmatrix} -0.00753 \\ -0.00625 \\ -0.17997 \end{pmatrix}$	-0.06029
4	$\begin{pmatrix} 0.19602 \\ -0.06722 \end{pmatrix}$	0.35788	$\begin{pmatrix} -0.39998 \\ -0.75592 \end{pmatrix}$	0.32517	$\begin{pmatrix} 0.06596 \\ -0.31302 \end{pmatrix}$	$\begin{pmatrix} -0.59994 \\ 1.30770 \end{pmatrix}$	$\begin{pmatrix} 0.03040 \\ -0.12241 \\ -0.27522 \end{pmatrix}$	-0.12241

Tabulation2 : Convergence of Conjugate Gradient FR method

K	\bar{X}^K	β	s	λ	X_{k+1}	∇F_{K+1}	$\tilde{f}(x_1, x_2)$	$R(\tilde{A})$
0	(2, -2)	-	$\begin{pmatrix} -4 \\ 14 \end{pmatrix}$	0.13217	$\begin{pmatrix} 1.47312 \\ -0.14692 \end{pmatrix}$	$\begin{pmatrix} 5.58604 \\ 1.59606 \end{pmatrix}$	$\begin{pmatrix} -2.14239 \\ 1.98942 \\ 6.14362 \end{pmatrix}$	1.99688
1	$\begin{pmatrix} 1.47 \\ -0.14 \end{pmatrix}$	0.15879	$\begin{pmatrix} -6.21516 \\ 0.63306 \end{pmatrix}$	0.23677	$\begin{pmatrix} -0.00024 \\ 0.00195 \end{pmatrix}$	$\begin{pmatrix} -0.00042 \\ 0.00195 \end{pmatrix}$	$\begin{pmatrix} 0.0000 \\ 0.0000 \\ 0.0000 \end{pmatrix}$	0.0000

Tabulation3 : Convergence of Conjugate Gradient FR method

K	\bar{X}^K	β	s	λ	X_{k+1}	∇F_{K+1}	$\tilde{f}(x_1, x_2)$	$R(\tilde{A})$
0	(1, 1)	-	$\begin{pmatrix} -6 \\ 11 \end{pmatrix}$	0.10487	$\begin{pmatrix} 0.37078 \\ -0.15357 \end{pmatrix}$	$\begin{pmatrix} 1.17606 \\ -0.64053 \end{pmatrix}$	$\begin{pmatrix} -0.11391 \\ 0.12771 \\ 0.39291 \end{pmatrix}$	0.13557
1	(0.37, -0.15)	0.01133	$\begin{pmatrix} -1.23798 \\ 0.51537 \end{pmatrix}$	0.3083	$\begin{pmatrix} -0.00843 \\ 0.00366 \end{pmatrix}$	$\begin{pmatrix} -0.0264 \\ 0.01608 \end{pmatrix}$	$\begin{pmatrix} -0.00006 \\ -0.00002 \\ 0.00019 \end{pmatrix}$	0.00004





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2	(-0.00,0.00)	0.00028	$\begin{pmatrix} 0.01966 \\ -0.00982 \end{pmatrix}$	1.25	$\begin{pmatrix} 0.01614 \\ -0.00862 \end{pmatrix}$	$\begin{pmatrix} 0.04732 \\ -0.0453 \end{pmatrix}$	$\begin{pmatrix} 0.00033 \\ 0.00026 \\ 0.00078 \end{pmatrix}$	0.000046
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Tabulation 4: Convergence of Conjugate Gradient FR method

K	\bar{X}^K	β	s	λ	X_{k+1}	∇F_{K+1}	$\tilde{f}(x_1, x_2)$	$R(\tilde{A})$
0	(1,1)	-	$\begin{pmatrix} -13.5 \\ -13.5 \end{pmatrix}$	0.03703	$\begin{pmatrix} 0.50010 \\ 0.50010 \end{pmatrix}$	$\begin{pmatrix} 3.37635 \\ 3.37635 \end{pmatrix}$	$\begin{pmatrix} 0.50026 \\ 1.25062 \\ 3.50114 \end{pmatrix}$	1.75067
1	(0.50,0.50)	0.06231	$\begin{pmatrix} -4.21119 \\ -4.21119 \end{pmatrix}$	0.04745	$\begin{pmatrix} 0.30034 \\ 0.30034 \end{pmatrix}$	$\begin{pmatrix} 1.21776 \\ 1.21776 \end{pmatrix}$	$\begin{pmatrix} 0.14438 \\ 0.37896 \\ 0.66792 \end{pmatrix}$	0.39702
2	(0.30,0.30)	0.12892	$\begin{pmatrix} -1.75291 \\ -1.75291 \end{pmatrix}$	0.01019	$\begin{pmatrix} 0.28251 \\ 0.28251 \end{pmatrix}$	$\begin{pmatrix} 1.07746 \\ 1.07746 \end{pmatrix}$	$\begin{pmatrix} 0.12491 \\ 0.32963 \\ 0.57945 \end{pmatrix}$	0.34466
3	(0.28,0.28)	0.78198	$\begin{pmatrix} -2.44074 \\ -2.44074 \end{pmatrix}$	0.02521	$\begin{pmatrix} 0.22098 \\ 0.22098 \end{pmatrix}$	$\begin{pmatrix} 0.65923 \\ 0.65923 \end{pmatrix}$	$\begin{pmatrix} 0.07041 \\ 0.18965 \\ 0.33047 \end{pmatrix}$	0.19684
4	(0.22,0.22)	0.36903	$\begin{pmatrix} -1.55071 \\ -1.55071 \end{pmatrix}$	0.02947	$\begin{pmatrix} 0.17528 \\ 0.17528 \end{pmatrix}$	$\begin{pmatrix} 0.41476 \\ 0.41476 \end{pmatrix}$	$\begin{pmatrix} 0.04150 \\ 0.11372 \\ 0.19672 \end{pmatrix}$	0.11731
5	(0.17,0.17)	0.39787	$\begin{pmatrix} -1.02698 \\ -1.02698 \end{pmatrix}$	0.03414	$\begin{pmatrix} 0.14022 \\ 0.14022 \end{pmatrix}$		$\begin{pmatrix} 0.02518 \\ 0.07002 \\ 0.12034 \end{pmatrix}$	0.07185





Dynamics of Velocity Dependent Potential Oscillator

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ABSTRACT

Understanding the dynamics of nonlinear systems has given rise to many challenges to overcome. This has brought about so many questions to be answered because most engineering systems are ubiquitously nonlinear in nature. Many of the nonlinear system have assumed polynomial oscillators, and very few nonlinear system are focused on nonpolynomial oscillators, such as position-dependent mass systems, Morse oscillator, etc. It is worth noting that various nonpolynomial oscillator systems arise in natural and mechanical systems. In the present work, we mainly focus on the nonploysnial oscillator in a simple nonlinear system and discuss the system dynamics using analytical and numerical results.

Keywords: Chaos, Harmonic Oscillator, Rotating Parabola System

INTRODUCTION

Generally the study of nonlinear dynamics is carried out broadly in two different directions according to the nature of the underlying systems. They are concerned mainly with the study of (i) integrable and (ii) non integrable systems in some restricted sense [1, 2]. Integrable systems with finite degrees of freedom described by nonlinear ordinary differential equations (odes) show regular and periodic behavior which can often be represented by analytic solutions. On the other hand, integrable systems with infinite degrees of freedom, described by nonlinear partial differential equations (pdes), often have the famous soliton solutions, infinite conservation laws etc. [1, 2]. However in this work, we mainly concentrate to finite and low dimensional systems.





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The nonintegrable systems, in general, exhibit irregular, a periodic and chaotic behavior with solutions having complicated singularity structure in the complex time plane. In recent years, especially the study of the chaotic phenomenon has become a very important area of research. The irregular and unpredictable time evaluation of many nonlinear systems is typically called "Chaos". It occurs in a wide range of natural systems such as mechanical oscillators like pendula or vibrating systems, in rotating or heated fluids, in laser cavities and in some chemical reactions and so on [3–7]. Its central characteristics is that the system does not repeat its past behavior (even approximately). The unique character of chaotic dynamics may be seen most clearly by imagining the system to be started twice, but from slightly different initial conditions. We can think of this small initial difference as resulting from measurement error. For non chaotic systems this uncertainty leads only to an error in prediction that grows linearly with time. For chaotic systems, on the other hand, the error grows exponentially in time. So that the state of the system is essentially unknown after a very short time. This phenomenon, which occurs only when the governing equations are nonlinear, is known as sensitivity to initial conditions. Henri Poincare (1854–1912), the prominent mathematician and theoretical astronomer, who studied dynamical systems, was the first to recognize this phenomenon. If prediction becomes impossible, it is evident that a chaotic system can resemble a stochastic system (a system subject to random external forces). However the source of the irregularity here is quite different. For chaos, the irregularity is part of the intrinsic dynamics of the system and not due to unpredictable outside influences. In recent years, investigation on few degrees of freedom systems have introduced many new concepts such as strange attractors, fractal dimensions, self similarity structures, Lyapunov exponents and correlation functions etc. [1, 5] which can be used to characterize this generic phenomenon. Nonlinear phenomena can be understood and mastered with a thorough understanding of the laws of nonlinear science. Researchers in the domains of mathematics, physics, chemistry, biology and epidemiology have invested in these nonlinear sciences in order to achieve this goal. In small variations its lead to large changes in and around the nature. So one can need to study the small variation in more concentration. In this work, initially the detail study made in the without and with damping coefficient of nonlinear harmonic oscillator.

Nonlinear Harmonic Oscillator

This is a remarkable nonlinear system which has the property that all its bounded periodic motions are simple harmonic even though the frequency is amplitude dependent. The system is a particle obeying the highly nonlinear equation of motion

$$\ddot{x} + \frac{\lambda x \dot{x} + kx}{1 - \lambda x^2} = 0, \quad \cdot = \frac{d}{dt} \quad (1)$$

The equation is obtainable from the Lagrangian

$$L = \frac{1}{2} \left[\dot{x}^2 + \frac{kx^2}{1 - \lambda x^2} \right], \quad (2)$$

where the canonical momentum p and the Hamiltonian H are given by

$$p = \frac{\partial L}{\partial \dot{x}} = \dot{x} (1 - \lambda x^2)^{-1} \quad (3)$$

$$H = \frac{1}{2} [p^2 (1 - \lambda x^2) + kx^2 (1 - \lambda x^2)^{-1}] \quad (4)$$

Solution of (2) has the simple harmonic form

$$x = A \sin(\omega t + \theta), \quad \omega^2 = \frac{k}{1 - \lambda A^2} \quad (5)$$

For studying regular and irregular motion of this oscillator in the presence of damping (α) and periodic forcing ($f \cos \omega t$), we consider two versions:

$$(1 - \lambda x^2) \ddot{x} + \lambda x \dot{x}^2 + kx + \alpha \dot{x} = f \cos \omega t \quad (6)$$

$$\ddot{x} + \frac{\lambda x \dot{x}^2 + kx}{(1 - \lambda x^2)} + \alpha \dot{x} = f \cos \omega t \quad (7)$$





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We find the equation 6 is more suitable for analytic studies and 7 convenient for numerical studies. Of course, it is possible to consider either one of them alone both for analytical and numerical investigations. However, we find the above two versions are convenient for our studies.

The Motion of a Particle on the Rotating Parabola

It is interesting to note that though the non polynomial nature of the force in equation 1 and its velocity dependence may appear unconventional and artificial, very similar equations have in fact been obtained for actual mechanical system in the form

$$\ddot{x} + \frac{\lambda x \ddot{x} + k x}{1 + \lambda x^2} = 0 \quad (8)$$

It governs the motion of a material point on a parabola rotating about its vertical axis with constant angular velocity. This equation differs from equation 1 only in the sign of denominator involves elliptic integrals of second and third kinds. This equation is obtainable from the Lagrangian

$$L = \frac{1}{2}[(1 + \lambda x^2)\dot{x} + k x^2] \quad (9)$$

$$H = \frac{1}{2}[p^2(1 + \lambda x^2)^{-1} + k x^2] \quad (10)$$

To study the periodic and chaotic behaviour related to the above system, we also include the linear viscous damping (α) and forcing ($f \cos \omega t$) in two different versions (as discussed above)

$$(1 + \lambda x^2)\ddot{x} + \lambda x \dot{x}^2 + kx + \alpha \dot{x} = f \cos \omega t \quad (11)$$

$$\ddot{x} + \frac{\lambda x \dot{x}^2 + kx}{(1 + \lambda x^2)} + \alpha \dot{x} = f \cos \omega t \quad (12)$$

Damped Version of Nonpolynomial Oscillators and Their Dynamical Behaviour

In the previous sections, we have considered oscillator systems without damping and they are exactly integrable. Hence we also discussed the behaviour of these systems through the solutions. But when damping forces are included in the above oscillators, they are difficult to integrate explicitly. In order to understand their dynamical behaviours, we wish to carry out a phase plane analysis.

Damped Nonlinear Harmonic Oscillator

We consider the differential equation of this system in the form

$$(1 + \lambda x^2)\ddot{x} + \lambda x \dot{x}^2 + kx + \alpha \dot{x} = 0 \quad (13)$$

where α is damping parameter. We write (13) as

$$V_x = \dot{x} = y$$

$$V_y = \dot{y} = \frac{(\lambda xy^2 + kx + \alpha y)}{(1 + \lambda x^2)} \quad (14)$$

The fixed or singular points are the solutions if $V_x = 0 = V_y$, or

$$\dot{y} = \frac{-(\lambda xy^2 + kx + \alpha y)}{(1 + \lambda x^2)} = 0 \quad (15)$$

Hence we have the origin (0,0) as the only singular point. To make a linearization, we construct a matrix A as usual in form

$$A = \begin{bmatrix} \frac{\partial V_x}{\partial x} & \frac{\partial V_x}{\partial y} \\ \frac{\partial V_y}{\partial x} & \frac{\partial V_y}{\partial y} \end{bmatrix} \quad (16)$$

For (14), we have at the origin

$$A(0,0) = \begin{bmatrix} 0 & 1 \\ -k & -\alpha \end{bmatrix} \quad (17)$$

To find the eigen value of the above matrix, we evaluate $\det(A - \lambda I) = 0$ so that





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$$\lambda^2 + \alpha y + k = 0 \quad (18)$$

Hence

$$\lambda_{1,2} = \frac{-\alpha \pm \sqrt{\alpha^2 - 4k}}{2} \quad (19)$$

Depending upon the magnitudes of α, k and sign of α various types of singular points can occur. They are enumerated in Table I.

Damped Motion of a Particle on a Rotating Parabola

Now we consider the equation of motion of this system in the form

$$(1 + \lambda x^2)\ddot{x} + \lambda x \dot{x}^2 + kx + \alpha \dot{x} = 0 \quad (20)$$

Where again α is the damping parameter (20) can be rewritten as

$$\begin{aligned} V_x &= \dot{x} = y \\ V_y &= \dot{y} = \frac{-(\lambda xy^2 + kx + \alpha y)}{(1 + \lambda x^2)} \end{aligned} \quad (21)$$

Again the singular point is the origin (0,0). Proceeding as before the eigen values of the linearized problem are

$$\lambda_{1,2} = \frac{-\alpha \pm \sqrt{\alpha^2 - 4k}}{2} \quad (22)$$

Then, various types of singular point can occur, depending upon the magnitudes of α, k and the sign of α which are enumerated in Table II.

CONCLUSION

In this work, the properties of the force-free nonpolynomial oscillators have been discussed and also the damped versions of these oscillators and the geometric properties have also been studied using phase plane analysis. The detailed results are summarized in Tables I & II.

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Table 1. Qualitative Behaviour of the Nonlinear Harmonic Oscillator

Parameters	Nature of oscillator	Nature of Singular point	Behaviour of the system
(a) $\alpha = 0$ (i) $\lambda < 0$	Free undamped oscillator	Elliptic point	2π -periodic solution





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(ii) $\lambda > 0$		hyperbolic point	Hyperbolic solution
(b) $\alpha > 0, k > 0$	Free damped oscillator		
(i) $\alpha^2 > 4k$	over damped	stable node	with no vibration the system dies out exponentially
(ii) $\alpha^2 = 4k$	critically damped	stable node	with no vibration the system dies out exponentially
(iii) $\alpha^2 < 4k$	under damped	stable spiral	oscillatory behaviour (not strictly periodic), decays exponentially with time.

Table 2. Qualitative Behaviour of the Motion of the Particle on the Rotating Parabola

Parameters	Nature of oscillator	Nature of Singular point	Behaviour of the system
(a) $\alpha = 0$			
(i) $\lambda < 0$	Free undamped oscillator	Elliptic point	2π -periodic solution
(ii) $\lambda > 0$		hyperbolic point	Hyperbolic solution
(b) $\alpha > 0, k > 0$	Free damped oscillator		
(i) $\alpha^2 > 4k$	over damped	stable node	with no vibration the system dies out exponentially
(ii) $\alpha^2 = 4k$	critically damped	stable node	with no vibration the system dies out exponentially
(iii) $\alpha^2 < 4k$	under damped	stable spiral	oscillatory behaviour (not strictly periodic), decays exponentially with time.





The Time Series Model: The Detailed Analysis of the COVID-19 Outbreak in Panvel (Navi Mumbai)

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ABSTRACT

It is essential to fully comprehend the patterns and dynamics of the disease in various geographical areas given the COVID-19 pandemic's significant global impact. The time series model investigates the transmission of COVID-19 from daily and cumulative cases to infection growth rates and the efficacy of local interventions by analyzing data points collected across time intervals. It also pinpoints critical turning points in the pandemic's evolution, such as peak infection, the effects of lockdowns, and the success of vaccination drives. The findings of the study add to our understanding of the dynamics of COVID-19 and provide insightful information that can be used to design practical public health plans, allocate resources more efficiently, and make informed decisions about how to combat the virus. Our study's ultimate goal is to provide evidence-based insights to decision-makers and healthcare workers for efficient COVID-19 response and management, while also advancing understanding of the pandemic's local effects.

Keywords: The time series model, COVID-19, Policy decisions, Public health measures.





INTRODUCTION

The COVID-19 pandemic, which has also disrupted the world economy, has affected millions of people. In order to make wise decisions as governments and healthcare organizations work to stop and lessen the spread of the virus, it is crucial to understand the patterns and dynamics of the virus within specific geographic areas. In this study, the thriving metropolis of Panvel (Navi Mumbai), located in the Indian state of Maharashtra, is studied using time series analysis of COVID-19 data. Panvel is a great case study for examining the COVID-19 transmission tendencies due to its significant economic activity and dense population. Time series analysis, a statistical method that examines data points gathered over successive time intervals, can provide important insights into the pandemic's trajectory in this area. With the help of this analysis, public health policies, resource allocation, and policy decisions can be made that will help to lessen the effects of the virus and protect the wellbeing of the residents of Panvel. In this study, we looked at a range of COVID-19 dissemination characteristics, including the daily and cumulative cases, the rising infection rate, and the effectiveness of local government initiatives. By analyzing the time series data, we can spot underlying patterns, seasonal variations, and possible connections with external factors like governmental regulations, immunization drives, and public health initiatives. A further goal of this research is to identify critical junctures in the spread of the pandemic in Panvel, such as peak infection periods, the results of lockdown measures, and the efficiency of vaccination campaigns. Knowing these landmarks can aid in the development of targeted initiatives to reduce the socioeconomic effects of the infection, enhance the healthcare system, and control ongoing epidemics. The findings of this time series study will advance our understanding of COVID-19 dynamics and provide useful data for academics, policymakers, and public health professionals. It is important to emphasize that the analysis's focus is only on Panvel and the data available as of May 2021. The findings may shed light on the regional dynamics of COVID-19, but they should be interpreted in the context of the region and may not necessarily be generalizable to other locations. However, the goal of this study is to advance our knowledge of the pandemic's local effects and add to the body of existing knowledge. The following sections of this study go into detail about the data collection and methodology, the time series data presentation and analysis, the major findings, and the implications and suggestions for Panvel's effective pandemic management. With the help of this research, we hope to arm policymakers and healthcare workers with knowledge that will help them address the ongoing problems caused by COVID-19.

LITERATURE REVIEW

Ramane *et al.* conducted a study on Indian consumer purchase behavior during the first lockdown (Lockdown 1.0) imposed due to COVID-19 [1]. Chu *et al.* conducted network analysis to analyze cross-country pandemic connectedness during COVID-19 using a spatial-temporal database [2]. Bodke explored epidemic outbreak detection and prediction using machine learning techniques [3]. Fulk *et al.* assessed the impacts of COVID-19 and social isolation on mental health in the United States of America [4]. Qi *et al.* conducted a time-series analysis and found an association between COVID-19 transmission in Mainland China and temperature and humidity [5]. Aruffo *et al.* developed a community structured model to study vaccine strategies for controlling the spread of COVID-19 [6]. Mirri *et al.* studied the potential role of particulate matter in the spread of COVID-19 in New York City during the spring of 2020 using time series analysis and machine learning [7]. Rwagasore *et al.* conducted an observational study to evaluate the effect of non-pharmaceutical interventions on COVID-19 in Rwanda [8]. Singh *et al.* utilized Support Vector Machine for the prediction of the COVID-19 pandemic based on time series data [9]. Murata *et al.* investigated the relationship between electoral processes and COVID-19 infections in Japan [10]. Sulasikin *et al.* used time series methods for forecasting and data-driven policy-making in handling the COVID-19 pandemic in Jakarta [11]. Zivkovic *et al.* proposed a hybrid genetic algorithm and machine learning method for predicting COVID-19 cases [12]. Cruz analyzed the impact of social distancing measures in São Paulo State, demonstrating the reduction in COVID-19 cases using time series analysis of deaths [13]. Zargari *et al.* analyzed the impact of mobility on COVID-19



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spread through a time series analysis [14]. Rui *et al.* employed a spatio-temporal multivariate time series model to analyze the spread of COVID-19 in the USA [15]. Neuhaan *et al.* examined the spatio-temporal distribution of COVID-19 in Cologne and its association with socio-economic factors [16]. Singh *et al.* performed a time series analysis of COVID-19 data to study the effect of lockdown and unlock measures in India [17]. Rashid *et al.* explored the effect of movement control orders during the COVID-19 pandemic on contractors [18].

METHODOLOGY

The study used secondary data obtained from the municipal corporation's Panvel health branch. The dataset covered the dates of 16 April 2020 and 20 May 2021 and contained information on daily sums for newly discovered patients, patients who passed away, and patients who had blood tests performed at various hospitals and testing facilities. Prior to analysis, the dataset was sorted and organized to make it simpler to review. The primary objectives were to calculate the rate of new patients and the rate of deceased patients. Calculating this required dividing the daily totals for deaths and new patients by the daily total for patients who underwent testing. The dataset was divided into two distinct time periods using the COVID-19 first wave and second wave. By dividing the data in this way, it was possible to spot any variations or trends between the two waves in the rate of new patients and deceased patients. By utilizing pertinent statistical tests and visualization techniques, significant results were attained. The dynamics of the pandemic in the city of Panvel were clarified by these findings.

RESULTS AND DISCUSSION

Descriptive Statistics

The statistical measures and ranges in Table No. 1 give important details about the overall number of COVID-19 positive cases, as well as new cases, recoveries, and deaths. The information makes clear each variable's variability, spread, and central tendencies, enabling comprehension of the overall COVID-19 situation. For each variable, the mean and median values offer an average and central tendency. As an illustration, the median and mean total positive cases are respectively 10,617 and 10,305, indicating a slightly skewed distribution. In this case, the standard deviation, which measures data variability or spread, is quite high for the majority of the variables, indicating significant fluctuations in the observed values.

Autocorrelation and Partial Autocorrelation

There is a significant but weak positive autocorrelation between consecutive observations (Table No.2). The correlation between observations decreases as the time lag increases. This indicates that the data may have some persistence or trend, but the influence of previous observations fades over time. At lag 1, there is a strong positive partial autocorrelation, indicating that the previous observation had a significant influence on the current observation. The influence of previous observations decreases as the lag increases. Data shows alternating patterns or cycles, indicating potential periodicity or seasonality. Some non-significant partial autocorrelations indicate that certain lags have little or no influence on the current observation. These findings shed light on the temporal dependency and patterns present in the data. The weak positive autocorrelation suggests some persistence, whereas the diminishing influence of previous observations suggests that the data may not be strongly correlated over longer time lags. The strong partial autocorrelation at lag 1 and alternating patterns suggest that the data may exhibit periodic or cyclical behavior. The presence of non-significant partial autocorrelations, on the other hand, suggests that certain lags may have little impact on the current observation (Table No.3).





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Time Series Model

For the New Patients (Per day) data, the ARIMA (1,1,0) model has moderate explanatory power ($R^2 = 0.818$) and stationarity (stationary $R^2 = 0.261$). The predictive performance of the model, as indicated by the RMSE, MAPE, MAE, and Max AE values, indicates a reasonable fit to the data. The high Max APE value of 738.2%, on the other hand, indicates that the model may have some instances of high prediction errors. The normalized BIC value of 7.990 indicates that the model's fit is consistent with the underlying data and is of low complexity.

Time series Model fit for Deceased Patients due to COVID 19

The ARIMA (0,2,1) model for COVID-19-related deaths in Panvel city has a high explanatory power ($R^2 = 0.999$) and stationarity (stationary $R^2 = 0.617$). The predictive performance of the model, as indicated by the RMSE, MAPE, MAE, and Max AE values, indicates a very good fit to the data. The normalized BIC value of 3.975 indicates that the model's fit is consistent with the underlying data and is of low complexity. Overall, the model appears to be a useful tool for forecasting and analyzing the number of COVID-19 patients who died in Panvel.

CONCLUSION

This study presents the results of a time series modelling analysis of COVID-19 spread in Panvel (Navi Mumbai). The ARIMA (1,1,0) model predicts the daily number of new COVID-19 patients, whereas the ARIMA (0,2,1) model predicts the daily number of deceased patients. These models effectively capture the data's variability and patterns. In Panvel, the average rate of positive COVID-19 test results is 19.81%. In Panvel, however, 3.47% of COVID-19 patients die as a result of the disease. In conclusion, the ARIMA models, specifically ARIMA (1,1,0) and ARIMA (0,2,1), are appropriate for predicting the number of new COVID-19 patients and deceased patients per day. The paper also discusses the rate differences between the first and second waves of the pandemic, with the second wave showing a higher rate of positive test results but a similar rate of deceased patients as the first wave.

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Table.1 Descriptive Statistics Table

Variables	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Total COVID 19 positive patients	10304.51	10617.00	8253.089	27576	26	27602
New patients (tested positive on the day)	109.225	57.000	125.9552	686.0	.0	686.0
Cured Patients	15044.58	12244.00	14209.633	52994	4	52998
Deceased patients	350.50	339.00	291.090	1078	1	1079
Rate of positive patients	19.8077	17.0314	13.71748877	158.5363	4.3771	162.9134
Rate of deceased patients	3.4709	3.4605	68314	4.9132	1.5384	6.4516





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Table.2 Table for Autocorrelations

Lag	Autocorrelation	Std. Error ^a	Box-Ljung Statistic		
			Value	df	Sig. ^b
1	.889	.062	204.074	1	.000
2	.887	.062	408.135	2	.000
3	.859	.062	599.247	3	.000
4	.837	.062	781.676	4	.000
5	.817	.062	956.044	5	.000
6	.792	.062	1120.636	6	.000
7	.740	.062	1265.025	7	.000
8	.721	.061	1402.289	8	.000
9	.680	.061	1525.110	9	.000
10	.652	.061	1638.375	10	.000
11	.597	.061	1733.680	11	.000
12	.582	.061	1824.858	12	.000
13	.564	.061	1910.694	13	.000
14	.517	.061	1983.232	14	.000
15	.501	.061	2051.543	15	.000
16	.469	.060	2111.738	16	.000

Series: NEW positive patients		
Lag	Partial Autocorrelation	Std. Error
1	.889	.063
2	.462	.063
3	.142	.063
4	.042	.063
5	.025	.063
6	-.015	.063
7	-.199	.063
8	-.031	.063
9	-.048	.063
10	-.016	.063
11	-.154	.063
12	.090	.063
13	.177	.063
14	-.106	.063
15	.026	.063
16	.028	.063



Shiroke *et al.*,**Table. 3 The Time Series Model ARIMA(1,1,0) for New Patients (Per day) data**

		Fit Statistic						
		Stationary R-squared	R-squared	RMSE	MAPE	MaxAPE	MAE	MaxAE
Mean		.261	.818	53.721	38.224	738.296	26.343	437.097
SE		.	.	.	.	.	.	.
Minimum		.261	.818	53.721	38.224	738.296	26.343	437.097
Maximum		.261	.818	53.721	38.224	738.296	26.343	437.097
Percentile	5	.261	.818	53.721	38.224	738.296	26.343	437.097
	10	.261	.818	53.721	38.224	738.296	26.343	437.097
	25	.261	.818	53.721	38.224	738.296	26.343	437.097
	50	.261	.818	53.721	38.224	738.296	26.343	437.097
	75	.261	.818	53.721	38.224	738.296	26.343	437.097
	90	.261	.818	53.721	38.224	738.296	26.343	437.097
	95	.261	.818	53.721	38.224	738.296	26.343	437.097

Table. 4 The Time Series Model ARIMA(0,2,1) for deceased patients due to COVID 19

		Fit Statistic						
		Stationary R-squared	R-squared	RMSE	MAPE	MaxAPE	MAE	MaxAE
Mean		.617	.999	7.137	2.570	59.037	3.250	78.420
SE		.	.	.	.	.	.	.
Minimum		.617	.999	7.137	2.570	59.037	3.250	78.420
Maximum		.617	.999	7.137	2.570	59.037	3.250	78.420
Percentile	5	.617	.999	7.137	2.570	59.037	3.250	78.420
	10	.617	.999	7.137	2.570	59.037	3.250	78.420
	25	.617	.999	7.137	2.570	59.037	3.250	78.420
	50	.617	.999	7.137	2.570	59.037	3.250	78.420
	75	.617	.999	7.137	2.570	59.037	3.250	78.420
	90	.617	.999	7.137	2.570	59.037	3.250	78.420
	95	.617	.999	7.137	2.570	59.037	3.250	78.420





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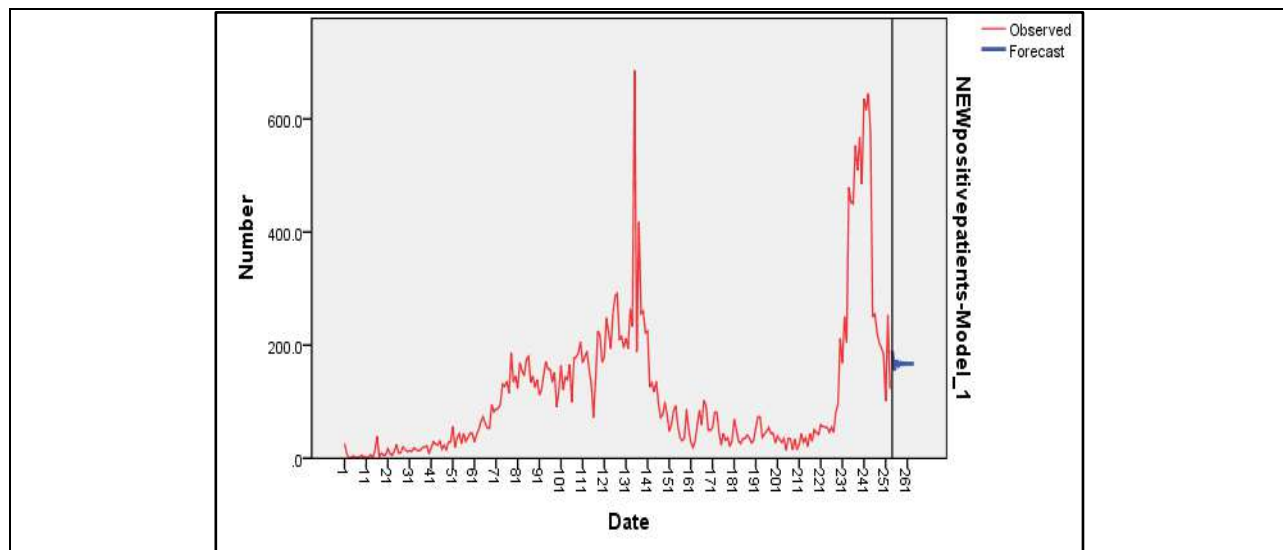


Fig. 1 Graph of New Positive Patients observed and forecast

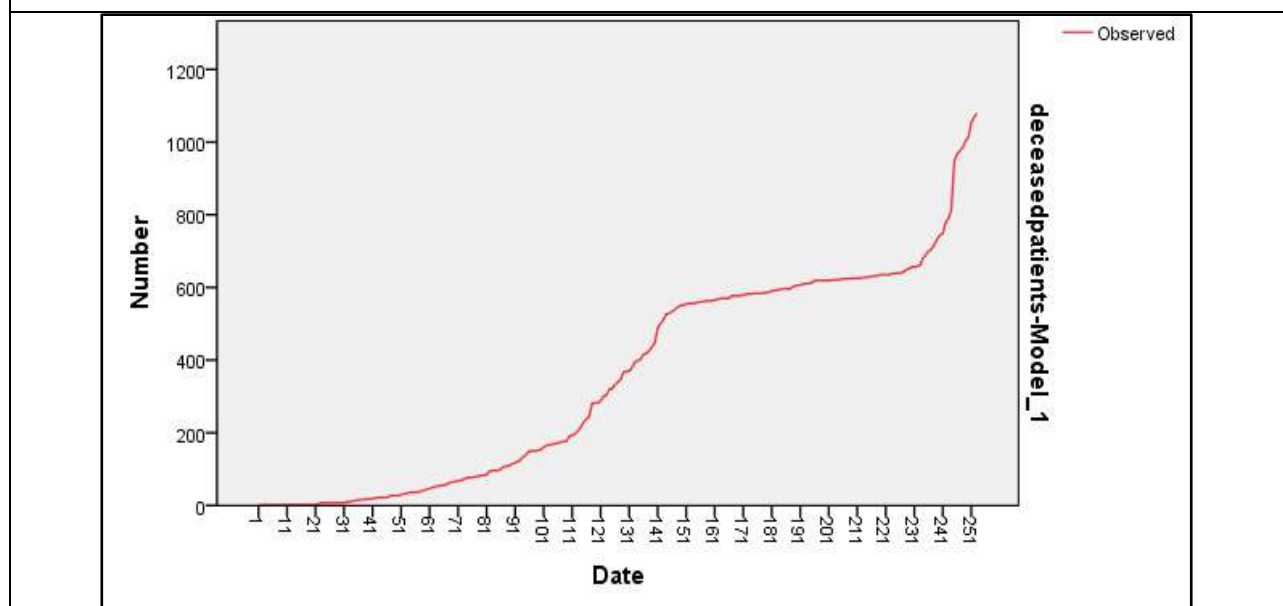


Fig. 2 Graph of deceased observed Patients





Nanocarrier Mediated Transdermal Drug Delivery Systems for the Management of Psoriasis: A Review

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ABSTRACT

Psoriasis is an incessant autoimmune skin disease of inflammatory pathophysiology. It is expressed by prolific growth and abnormal differentiation of keratinocytes. The prevalence of psoriasis is in around 2-5% of the world population. The studies dictate that around 35% of people have moderate to severe psoriasis. Several approaches have been explored by researchers, taking in regard different anti-psoriasis drugs, but psoriasis treatment remains a challenge because of its chronic recurring nature and lack of perfect carrier for a safe and effective delivery of anti-psoriatic drugs. Currently nano carriers have gained prevalent purpose for unscathed and effective treatment of psoriasis. Novel nano carriers like liposomes, transferosomes, niosomes, ethosomes, SLN, NLC, microspheres, micelles, nanocapsules, dendrimers etc. have been thoroughly investigated. This review focuses on existing treatment options along with the recent developments in this direction.

Keywords: Psoriasis, Nanocarriers, Anti-psoriatic drugs, Delivery system, Nanoparticle.





INTRODUCTION

Psoriasis is an incessant inflammatory, autoimmune disorder of the dermis and epidermis. The worldwide occurrence of psoriasis is 2-5%[1]. It is usually characterized by thickening of skin; excessive growth of red scaly patches on the skin. It involves series of cellular changes like epidermal hyperplasia including vascular hyperplasia, ectasia and generation of inflammatory cells such as T-lymphocytes, neutrophils etc. around the affected skin. [2, 3]. Psoriasis is categorized as chronic plaque, guttate, pustular, and erythrodermic based on the severity of the patient's condition, location of the rashes and extra clinical characteristics [4]. Among these, chronic plaque psoriasis has the highest incidence rate and occurs early before the age of 40 years and it affects both male and female [5]. The classification of types of psoriasis is shown in Table 1.

Pathophysiology of Psoriasis

An array of events is followed in the pathogenesis of psoriasis, these are sequenced in Fig. 1. The contrast between normal and psoriatic skin is elaborated in Table 2.

Challenges in Psoriasis Treatment

The main challenges in curing psoriasis are described here.

(a) Lack of Suitable Carrier: The main problem is the selection of an expedient carrier with suitable physicochemical properties, which on addition change the absorption pattern and hence modifying the effect of drug. Problems encountered with traditional carriers could be potentially resolved through the use of unique carriers[11].

(b) Absence of Suitable Animal Model: Another challenge in the optimal drug delivery system selection is the election of a suitable animal model[12]. While many animal models based on immunology and genetics have been developed but none of them accurately reflects the traits of psoriasis without certain limitation[13, 14].

Various Treatment Options for Psoriasis

Generally, there are three main types of therapy for psoriasis **a)** Topical treatment **b)** Phototherapy **c)** Systemic therapy. Firstly, topical treatments are taken into consideration. When topical therapy is ineffective then phototherapy is suggested[15]. Detailed descriptions of anti-psoriatic drugs with their novel carrier's system for delivery are given in Table 3. Conventionally, topical medication is used for mild psoriasis, but the absorption rate is slow. In advanced stages of psoriasis, systemic therapy is chosen. In case of systemic therapy, dose administered is high, which might show undesired effect. The pharmaceuticals adopted in the treatment of moderate to severe psoriasis have exorbitant cost. The traditional topical medications are economic but due to the chronic recurrent nature, psoriasis remains a challenge to treat traditionally (topical, oral and systemic) as shown in Fig 2. The overuse of highly potent corticosteroids can cause thinning of the skin and other side effects, while coal tar and dithranol are less effective. In systemic therapy drug like methotrexate, cyclosporine, and acitretin produce significant side effects, low visual and cosmetic appeal leading to poor patient compliance[16]. The available conventional formulation for psoriasis treatment encounters problems such as increased dosing frequency, side effects and decreased safety and efficacy. None of these treatments have been proven to be safe and effective. Additionally the traditional formulation have unaesthetic appearance and toxic effects when used for extended period of time[17, 18]. The need of a novel delivery system cropped up. Extensive investigation is being carried out to accomplish a safe and effective treatment of psoriasis via novel carriers[19]. Numerous approaches using novel carriers offered a variety of pros like enhanced encapsulation efficiency, increased biocompatibility, bioavailability, reduction in dose dosing frequency leading to improved patient compliance[20, 21].



Virendra Kumar Singh *et al.*,**Prospective Management of Psoriasis**

Recently, several attempts were made to utilize the NDDS approach to improve topical drug formulations used in psoriasis. The most widely used drug delivery systems include lipid-based nanoparticles (i.e., nanoemulsion, SLN, nanocapsules, nano suspensions, liposomes, liquid nanocrystal, lipid drug conjugates) and polymeric based nanocarriers such as polymeric nanoparticles, micelles, polymer drug conjugates as shown in Table 3[23].

Classification of Novel Nanocarriers

Numerous adaptable and intelligent nanocarriers have been created as cutting-edge medication delivery systems for dermal use[37, 38]. The nanocarriers mentioned in this review fall in four main classes:

- 1) **Nanocarriers based polymers:** micelles, polymeric nanoparticles, dendrimers, nanosphere, and nanocapsule.
 - 2) **Nanocarriers based lipids:** liposomes, solid lipid nanoparticles, nanostructured lipid carriers and Lipospheres.
- Figure 3 illustrates many types of nanocarriers used to treat psoriasis.

Nanocarriers based on polymers

Various medicinal agents, including synthetic medications, herbal remedies, vitamins, peptides, and other substances, are delivered via polymers. The size range of polymer-based nanocarriers ranges from 10-1000 nm, and they are often constructed from environmentally benign polymers[40, 41]. Due to their simplicity in preparation, ability to distribute medications precisely, and safety-related considerations, polymer-based nano-formulations have become excellent delivery systems. Additionally, when applied topically, they are structurally stable and capable of maintaining it for a longer period of time[42, 43].

Polymeric micelles

These are self-assembling nano-sized (5–100 nm) colloidal particles with a hydrophobic core and hydrophilic shell, used as pharmaceutical carriers for water insoluble drugs. These carriers High drug loading capacities, less drug degradation, adverse effects, and enhanced bioavailability. Drug-polymer covalent attachment or physical entrapments are both viable methods for achieving drug loading in a micelle[44]. These micelles nanocarriers have applications in delivery of anticancer drug, antifungal agents, gene delivery, and also for the delivery of anti-psoriatic agents[45]. Recently the therapeutic gene for treating psoriasis has also been delivered via polymeric micelles. In this context, Fan *et al.* created modified specific si-RNA loaded polyethylene glycol, poly L-lysine, poly L-leucine micelles[46].

Polymeric nanoparticle

Nanoparticles generally vary in size from 10 to 1000 nm. Polymeric nanoparticles are of two types – nanospheres and nano-capsules depending on the arrangement of drug in the polymer system. In nanosphere drug is entrapped or dispersed in the polymer matrix. Polymers used can be either biodegradable or non-biodegradable in nature. Biodegradable polymers are significantly used as potential drug delivery systems in the controlled or site-specific delivery of drugs or bioactive such as DNA, proteins, peptides and genes through various routes of administration[47].

Dendrimers

A class of well-defined hyper branched polymers known as dendrimers was initially created under the name cascade polymers[48]. A new family of dendrimers described by Tomalia *et al.* in 1983 called poly-amidoamine dendrimers, sometimes referred to as PAMAM dendrimers which is blend of amines and amides[49]. Dendrimers proffer space for the loading of drug in the central unit or even interact with the functional groups via electrostatic or covalent bonds. The drug is released from the dendrimer by enzymatic degradation or by change in physical environment (pH or temperature change)[50]. Dendrimers have a series of advantages such as increased solubilization, controlled drug release and formation of prodrugs, that is why they have great applications in the drug delivery system. Dendrimers are used for distribution of antiviral, NSAIDS, antihypertensive, anticancer and anti-psoriatic drugs etc[51, 52].



**Virendra Kumar Singh *et al.*,****Nanosphere**

In this type of polymeric nanoparticle, drug is entrapped or dispersed in the polymer matrix. Polymers used can either be biodegradable or non-biodegradable. Biodegradable polymeric nanoparticles are significantly used as potential drug delivery systems in the controlled or site-specific delivery of drugs or bioactive such as DNA, proteins, peptides and genes [53]. Polymeric nanoparticles deliver the drugs used in various diseases and dermatological disease including psoriasis. Batheja *et al.*, developed nanospheres in a gel formulation and evaluated its permeation potential by using human cadaver skin exhibited enhanced drug permeation from tyrosphere as compared to aqueous nanosphere formulation. [54].

Nanocapsules

Nanocapsules are polymeric nanoparticles in which one or more active core material is surrounded by polymeric matrix (shell)[55]. Nano capsule can provide as nano drug carriers to achieve controlled release as well as proficient drug targeting. Polymeric Nanocapsules are a valuable means for dermal applications. The primary advantages of Nanocapsules include sustained release, increased drug selectivity and effectiveness, improved drug bioavailability and reduced drug toxicity[56].

Nanocarriers based on lipids

Generally, lipid-based carriers are comprehended from physiological lipids. Therefore, they are considered to be safe and free from toxicity. Lipid-based nanocarriers are useful in many aspects such as controlled drug release, enhanced stability, biodegradability, drug targeting, increased drug load and cost-effectiveness.

Liposomes

Liposomes are phospholipid bi-layered vesicular structures enclosing an aqueous compartment. Liposomes are suitable for carrying both hydrophilic (in aqueous core) and lipophilic drugs (in lipid bilayer) due to its amphiphilic nature[57]. Dermal delivery of drugs through liposomes is favored by its small size, lamellar, elastic and fluid properties[58]. Phospholipids is main component of liposomal systems, are easily integrated with the skin lipids and maintain the desired hydration condition to improve drug penetration and localization in the skin layers[59]. Liposomes are used in topical as well as transdermal drug delivery, they act as penetration enhancer due to diffusion of phospholipid molecules or nonionic surfactants into the lipid covering of the stratum corneum and promote localized higher drug concentrations[60]. Calcipotriol, a vitamin D analogue was successfully delivered in lipopolymer poly(ethylene glycol)-distearoylphosphoethanolamine (PEG-DSPE) liposomes with a significant increase in drug deposition into the stratum corneum[61]. Doppalapudi *et al.*, developed liposomal nanocarriers containing psoralen for safe and effective PUVA therapy of psoriasis with better skin penetration[62]. Wadhwa *et al.*, prepared fusidic acid (FA) loaded liposomal system for proficient management of plaque psoriasis[63].

Solid lipid nanoparticles

Solid lipid nanoparticles are nanoparticles systems having size ranging from 50 to 1000 nm. They are composed of physiological lipids and surfactants which form SLN on dispersion in water[64]. SLN offers exclusive advantages such as large surface area, high drug loading capacity, minimal skin irritation, protective and extended drug release. It is used in various cosmetic and dermatological preparations. Gambhire *et al.* (2011) reported the preparation and optimization of dithranol loaded solid lipid nanoparticles[65].

Nanostructured lipid carriers

Nanostructured Lipid Carriers (NLCs) represent an advanced form of solid lipid nanoparticles (SLNs) with improved properties of drug loading, modifying drug release profile and stability on storage. NLCs are promising drug carriers for topical application because of their improved skin retention properties[66]. Compared with other topical vehicles like creams, tinctures, lotions and emulsions, the NLCs have several advantages such as controlled drug release, negligible skin irritation, protection of active compounds and targeted drug delivery[67]. NLCs are produced by mixing solid lipids (stearic acid, palmitic acid, carnauba wax, cetyl palmitate) with liquid lipids (oleic acid, isopropyl myristate) and form to a lipid matrix with a specific structure. Lin *et al.* (2010) combined calcipotriol



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and methotrexate in nanostructured lipid carriers for topical delivery, and reported efficient delivery of the drugs[68].

Liposphere

Lipospheres are lipid-based nanoparticulate carrier which is composed of solid lipid core surrounded by a single unit phospholipid layer that may entrap the drug or coat with the drug. The emulsifying agent or stabilizing agent is used to form uniform coating around the core material and to facilitate partitioning of the drug between the lipid and aqueous phases[69]. Lipospheres have been successfully used orally, intravenously and by transdermal route for the treatment of various ailments including psoriasis.

Nanoemulsion

Nanoemulsions are biphasic dispersion having droplet size ranging 5 nm to 100 nm, which may be either water in oil emulsion or oil in water emulsion[70]. The small droplet size can resist the physical destabilization caused by gravitational separation, flocculation and/or coalescence. It also avoids the creaming process because the droplet's Brownian motion is enough to overcome the gravitational separation force. Nanoemulsions can be delivered in several dosage forms like liquids, creams, sprays, gel, aerosols, and can be administered via various routes like topical, oral, intravenous, intranasal, pulmonary and ocular[71]. Khandavilli and Panchagnula (2007) formulated a nanoemulsion (NE) to achieve penetration of paclitaxel into deeper skin layers while minimizing the systemic escape[72]. Bernardi *et al.* (2011) formulated rice bran oil nanoemulsions and evaluated it for irritation potential and moisturising activity on volunteers with normal and diseased skin types[73].

Ethosomes

Ethosomes are soft, flexible and noninvasive delivery carriers. It is mainly composed of phospholipids, ethanol and water. The characteristic feature of Ethosomes is its high ethanol concentration which is responsible for disturbing the organization of skin lipid bilayer. Thus, these vesicles based on ethanol easily penetrate the stratum corneum and are reported to be safe for pharmaceutical and cosmetic use[74]. Ethosomes are suitable for topical drug delivery as they remain confined to the upper layer of stratum corneum. They have also been used for dermal, transdermal delivery of numerous drugs for the treatment of several dermal diseases like alopecia, dermatitis and psoriasis[75].

CONCLUSION

A variety of treatments are already available for psoriasis, still the treatment remains a challenge due to the reoccurring nature of the ailment. In order to safely manage this disease, a new approach has been adopted by introducing nanoparticle-based drug delivery. This might combat with the limitations of the conventional drug therapy and also minimize the dose and its frequency, thereby improving patient compliance. Nanocarriers such as liposomes, Ethosomes, Lipospheres, SLNs, polymeric nanoparticles, NLCs, nanocapsule, dendrimers, gold nanoparticles, silver nanoparticles, etc. have successfully employed for anti-psoriatic drug delivery. These carriers clearly present themselves as a tool to overcome the challenges associated with topical anti-psoriatic drug therapy.

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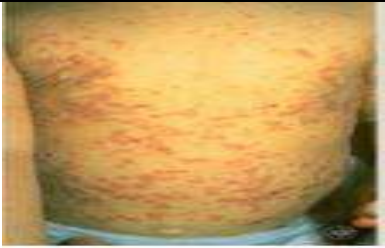


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Table 1: Categorization of Psoriasis [6, 7].

Types	Image	Signs and Symptoms
Plaque psoriasis		<ul style="list-style-type: none"> • Most people have plaque psoriasis. • <u>Characteristic Feature</u>: Silvery-white scale affecting elbows, knees, lower back, and scalp. • It is the most prevalent types of psoriasis.
Guttate psoriasis		<ul style="list-style-type: none"> • Children and the young are more susceptible to guttate psoriasis. • <u>Characteristic Feature</u>: Tiny red scaly patches across the skin.
Pustular psoriasis		<ul style="list-style-type: none"> • It is rigorous type of psoriasis. • <u>Characteristic Feature</u>: Small bumps show on palms and soles causing discomfort and pain. Puss containing bumps will dry out and produced brown spot on the skin.
Flexural psoriasis		<ul style="list-style-type: none"> • <u>Characteristic Feature</u>: It occurs in skin folds, armpits, under the breast and between buttocks.⁷⁸ • It can also affect the genitals. It is not usually scaly.



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Erythrodermic psoriasis		<ul style="list-style-type: none"> Most common types of psoriasis occur only in 1-2% of people. <u>Characteristic Feature:</u> Skin looks like it is burned. Patient feels severe hot or cold and deep burning sensation.
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Table 2: Contrast between normal and psoriatic skin [10].

S. No	Feature	Normal Skin	Psoriatic Skin
1	Blood Vessel	Small	Dilated and torturous
2	Inflammatory cells	Absent	Present
3	Abscess Formation	Absent	Present
4	Epidermis	Thin	Thickened
5	Scaly skin	Absent	Red, White scaly skin

Table 3: Anti- Psoriatic Drugs And their Novel carrier system

S.No	Novel carrier system	Anti- psoriasis drug	Method of preparation
1.	Liposome [24]	Tacrolimus	Self-assembly of the triblock copolymer
2	Liposomes [25]	Capsaicin	Thin film hydration
3	Ethosomes [26]	Methotrexate	Extrusion method
4	Liposomes [27]	Tretinoin	Fusion method
5	Nano emulsion [28]	Clobetasol propionate	Aqueous phase titration method
6	SLN [29]	Mometasone Furoate	Solvent injection method
7	Dendrimers [30]	8-methoxypsoralene	Divergent method
8	Microemulsion [31]	8-Methoxsalen	Hot homogenization
9	Nanostructured lipid carrier [32]	Cyclosporine	Modified hot Homogenization method
10	Polymer based nanocapsules [33]	Dexamethasone	Polymeric layer at interface
11	PEG based liposomes [34]	Calcipotriol	film hydration method
12	NLC [35]	Fluticasone propionate	Modified micro emulsion Method
13	Nanostructured lipid carrier [36]	Triamcinolone acetoneide	Modified emulsification ultrasonication



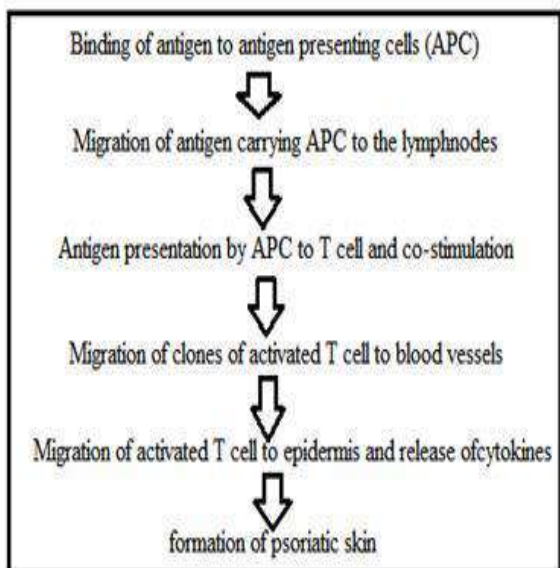
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Fig. 1. Pathogenesis of psoriasis [8, 9].

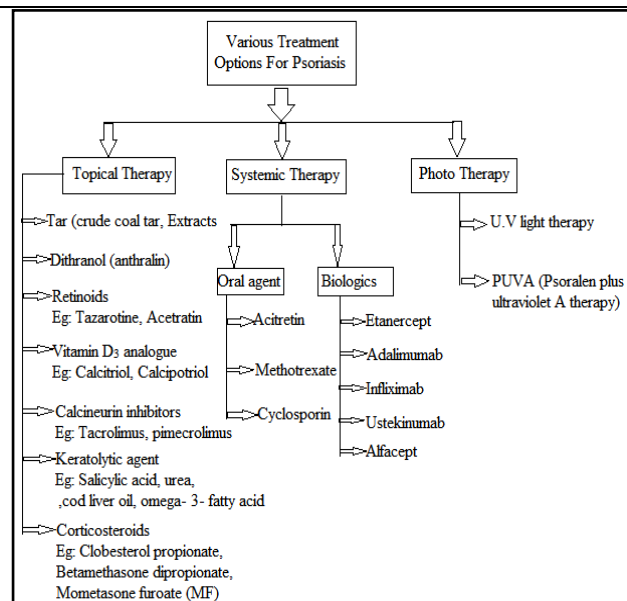


Fig. 2 Medication options for Psoriasis. [22].

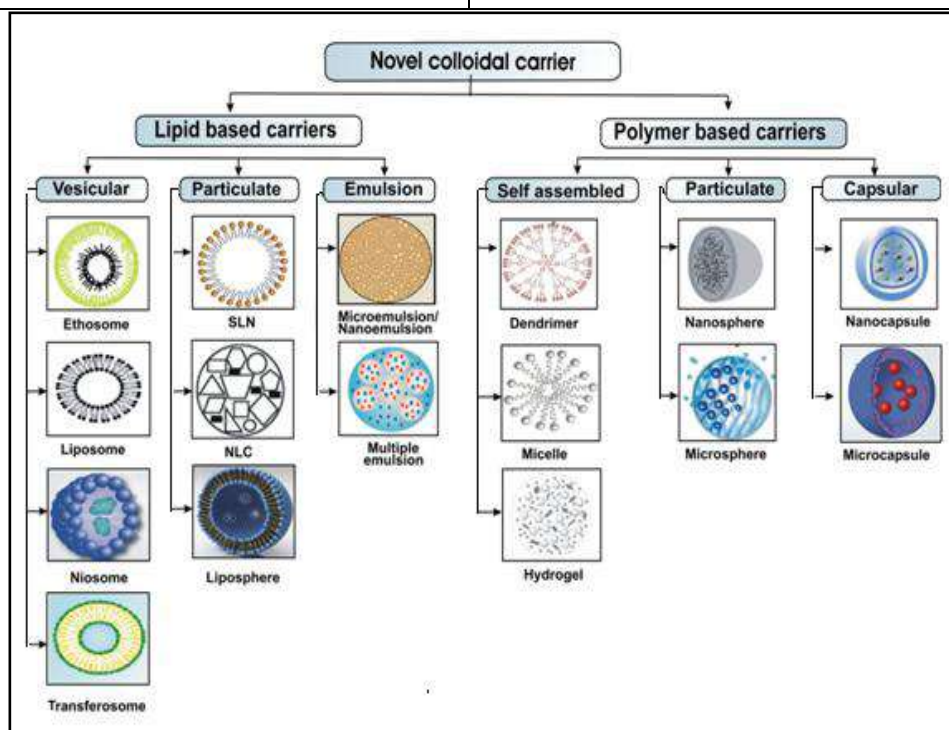


Fig. 3 Variety of nanocarriers used in Anti-psoriatic Drugs [39].





Bioanalytical Method Development and Validation for Linagliptin in API and Combination Formulations: A Comprehensive Review

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ABSTRACT

This in-depth review article thoroughly investigates the ever-evolving landscape of bioanalytical method development and validation concerning Linagliptin, a critical element in type 2 diabetes management. The paper provides a detailed exploration of various analytical techniques, encompassing HPLC (High-Performance Liquid Chromatography), LC-MS/MS (Liquid Chromatography – Tandem Mass Spectroscopy), NMR (Nuclear Magnetic Resonance), LC-MS (Liquid Chromatography – Mass Spectroscopy), and GC (Gas Chromatography), offering a nuanced assessment of their respective strengths and limitations. The focus remains on adhering to regulatory guidelines from the FDA and EMA to ensure the precision and trustworthiness of analytical data in pharmaceutical development. Furthermore, the article delves into emerging trends and technologies, such as microfluidic systems, artificial intelligence, and the miniaturization of analytical methods. It also underscores avenues for future research, such as enhancing method sensitivity, automation, and real-time monitoring, paving the way for further progress in Linagliptin analysis.

Keywords: Linagliptin, Bioanalytical Method Development, Method Validation, Regulatory Compliance, Analytical Techniques, Pharmaceutical Analysis, Diabetes Management.



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INTRODUCTION

Diabetes mellitus, a chronic metabolic disorder characterized by elevated blood sugar levels (hyperglycemia), poses a significant global health challenge. Among the various therapeutic strategies, dipeptidyl peptidase-4 (DPP-4) inhibitors have emerged as a crucial component in the management of type 2 diabetes [1][2]. Linagliptin, a member of this class, has garnered substantial attention in recent years due to its unique pharmacological characteristics and clinical advantages[3]. Being a once-daily, highly selective DPP-4 inhibitor, Linagliptin operates via a distinctive mechanism by preventing the enzymatic breakdown of incretin hormones like glucagon-like peptide-1 (GLP-1) and glucose-dependent insulintropic polypeptide (GIP)[4][5]. This, in turn, enhances glucose-dependent insulin secretion and suppresses glucagon release, ultimately leading to improved glycemic control [6]. Moreover, Linagliptin has demonstrated a favorable safety profile, with a reduced risk of hypoglycemia and weight neutrality. Its efficacy, tolerability, and convenient dosing regimen make it a promising therapeutic option for individuals with type 2 diabetes [7]. This comprehensive review aims to delve into the analytical methods employed for the quantification of Linagliptin in both its active pharmaceutical ingredient (API) and combination formulations, shedding light on the critical role of bioanalytical research in advancing Linagliptin's clinical utility. Bioanalytical methods play an indispensable role in pharmaceutical research, making a substantial contribution to various facets of drug development, safety evaluation, and efficacy assessment [8]. These methods are pivotal in characterizing the pharmacokinetics and pharmacodynamic of new drug candidates, ensuring their safety and effectiveness in clinical use. Bioanalytical techniques allow for the quantification of drugs and their metabolites in biological matrices, providing critical data on drug absorption, distribution, metabolism, and excretion (ADME)[9][10]. This information aids in selecting the most promising compounds, optimizing dosing regimens, and identifying potential drug-drug interactions, thereby accelerating the drug discovery process[11]. Furthermore, bioanalytical methods are instrumental in assessing the bioequivalence of generic formulations, ensuring that patients receive consistent and reliable treatments[12]. They also play a vital role in monitoring drug levels in patients, helping to tailor individualized dosages and enhance therapeutic outcomes while minimizing adverse effects. In addition to their impact on drug development, these methods are vital for post-marketing surveillance, enabling continuous safety monitoring and the identification of rare adverse events. With the aid of state-of-the-art analytical tools and technologies, bioanalytical methods have become essential cornerstones in pharmaceutical research, safeguarding the well-being of patients and contributing to the development of innovative and safer therapeutic interventions [13].

The objectives and scope of this comprehensive review paper are multifaceted, aiming to provide a thorough examination of bioanalytical method development and validation for Linagliptin in both its active pharmaceutical ingredient (API) and combination formulations. We endeavor to present a holistic understanding of Linagliptin's analytical landscape, encompassing various analytical techniques, method development strategies, and validation processes[14]. Our primary objectives include elucidating the mechanisms of Linagliptin analysis, exploring the challenges and complexities in quantifying this potent antidiabetic drug, and assessing the applicability of developed methods in both API and combination formulations [14][15]. Additionally, we will delve into the comparative analysis of these methods, highlighting their strengths and limitations, and discuss their alignment with regulatory considerations[16]. Through the synthesis of pertinent literature, we endeavor to provide readers with an informative and up-to-date resource that will aid researchers, analysts, and pharmaceutical professionals in advancing their knowledge and practices in the field of Linagliptin analysis[17][18].

Chemistry of Linagliptin

Linagliptin, with its chemical name as 8-(3R-amino-1-piperidinyl)-7-but-2-ynyl-3,4-dihydro-3-methyl-1H-pyrido[3,4-b]indole-2(1H)-one, serves as a potent dipeptidyl peptidase-4 (DPP-4) inhibitor employed in the management of type 2 diabetes[19]. Presented here is a concise yet thorough examination of its molecular structure and pertinent physicochemical characteristics.



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Chemical Structure

Linagliptin exhibits a remarkable and distinct chemical configuration, featuring a pyrido[3,4-b]indole-2(1H)-one core with a piperidinyl functional group and an ethynyl group ($C\equiv C$) connected at the 7th position of the pyridine ring. Figure 1 illustrates a molecular diagram of Linagliptin for visual reference.

Physicochemical Properties: Understanding the physicochemical properties of Linagliptin is crucial for selecting appropriate analytical methods and conditions for its analysis.

Solubility: Linagliptin exhibits limited solubility in aqueous solutions, which can pose challenges in the development of dissolution methods and sample preparation for bioanalysis. It is sparingly soluble in water but dissolves well in organic solvents such as methanol and acetonitrile, making these solvents suitable for analytical method development and sample extraction[20].

Stability: Linagliptin is known for its chemical stability, which is an essential consideration in pharmaceutical analysis. It remains stable under a range of storage conditions, including exposure to light, heat, and humidity. Stability studies are conducted to confirm the robustness of analytical methods[21].

pKa: Linagliptin has a pKa (acid dissociation constant) of approximately 5.4. This value is important when designing and optimizing chromatographic methods, especially for ionizable compounds, as it affects the compound's ionization state and retention on columns[22].

These physicochemical properties provide valuable insights into the behavior of Linagliptin during analytical method development and sample preparation, ensuring the selection of appropriate solvents, chromatographic conditions, and stability assessment protocols.

This comprehensive review paper provides a thorough exploration of Linagliptin, a vital drug in type 2 diabetes management. It offers an in-depth analysis of Linagliptin's chemical structure, accompanied by a table summarizing key physicochemical properties. The paper delves into its clinical applications, efficacy, safety, and comparative studies, shedding light on its role as a DPP-4 inhibitor and its cardiovascular effects. Additionally, it discusses analytical methods for Linagliptin quantification, encompassing bioanalytical method validation.

In pharmaceutical development, regulatory requirements for bioanalytical method validation are crucial to ensure the accuracy, reliability, and reproducibility of analytical data, especially in the context of Linagliptin analysis. Both the U.S. Food and Drug Administration (FDA)[17], and the European Medicines Agency (EMA)[20], have established guidelines that outline the essential elements for method validation in drug development. The FDA's "Guidance for Industry: Bioanalytical Method Validation" and EMA's "Guideline on Bioanalytical Method Validation" are foundational documents in this regard. These guidelines provide a comprehensive framework for the validation of bioanalytical methods, emphasizing key parameters such as specificity, accuracy, precision, linearity, and robustness. Method validation is expected to be conducted in accordance with these guidelines to ensure the reliability of analytical data generated during drug development. For Linagliptin analysis methods, compliance with these regulatory requirements is of utmost importance. Ensuring that the methods meet these guidelines assures that the data generated are suitable for pharmacokinetic, pharmacodynamic, and toxicokinetic assessments. It also enhances the likelihood of regulatory approval by demonstrating the validity and reliability of the methods used in the assessment of Linagliptin's safety and efficacy[53][54][55].

These regulatory considerations serve as a foundation for pharmaceutical companies and research institutions involved in Linagliptin drug development, emphasizing the importance of adhering to established guidelines to produce accurate and trustworthy analytical results. Emerging trends and technologies in bioanalytical method development for Linagliptin and related drugs are poised to revolutionize pharmaceutical research. Recent advances include the integration of microfluidic systems with mass spectrometry (MS) for enhanced sensitivity and reduced sample volumes [56]. Furthermore, the utilization of artificial intelligence (AI) and machine learning algorithms to optimize method parameters and predict degradation pathways has gained prominence [57]. In parallel, the advent of novel stationary phases in high-performance liquid chromatography (HPLC) and advancements in ion mobility spectrometry (IMS) have improved selectivity and separation efficiency [58][59]. The integration of miniaturized, chip-based devices for on-site analysis and point-of-care testing is also becoming a focus [60]. These innovations



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promise faster, more cost-effective, and highly sensitive methods for Linagliptin analysis, streamlining drug development and clinical assessment. In the future, bioanalytical method development for Linagliptin analysis should explore various avenues for improvement, ensuring that these methods keep pace with evolving pharmaceutical research and clinical demands. Research endeavors could focus on enhancing method sensitivity, particularly for trace-level detection [61]. Miniaturization of analytical techniques, such as microfluidic systems and lab-on-a-chip devices, should continue to be explored to reduce sample and reagent consumption while improving portability [62]. Automation of sample preparation and analysis workflows, including robotics and high-throughput screening, could lead to more efficient and reproducible assays [63]. Furthermore, efforts to integrate in-line and real-time monitoring techniques, such as process analytical technology (PAT), are pivotal for continuous manufacturing and quality control [64]. Lastly, novel approaches like the incorporation of electrochemical and optochemical sensors offer promising alternatives for Linagliptin analysis [65]. These suggested areas for future research in Linagliptin method development provide a roadmap for advancing analytical techniques and keeping them aligned with the evolving needs of pharmaceutical research and development.

CONCLUSION

In conclusion, this review has comprehensively explored the landscape of bioanalytical method development and validation for Linagliptin in both its active pharmaceutical ingredient (API) and combination formulations. The key findings of this review encompass the evaluation of various analytical techniques, such as HPLC, LC-MS/MS, NMR, LC-MS, and GC, highlighting their strengths and weaknesses in terms of sensitivity, speed, cost-effectiveness, and applicability to different matrices. Importantly, it underscores the critical importance of adhering to regulatory requirements, as outlined by agencies like the FDA and EMA, to ensure the reliability of analytical data in pharmaceutical development. Based on the findings, it is evident that LC-MS/MS emerges as a preferred method, offering high sensitivity and speed, making it well-suited for pharmacokinetic studies and the analysis of Linagliptin in biological matrices. However, the choice of the best method should be tailored to the specific requirements of the analysis, such as quality control in routine API batches (where HPLC-UV may suffice) or investigating degradation products (where LC-MS may be more suitable). Moreover, this review has highlighted the exciting future prospects in bioanalytical method development, including trends like microfluidic systems, artificial intelligence, and miniaturization, which promise to further revolutionize Linagliptin research. In the broader context, this review reiterates the profound significance of bioanalytical methods in Linagliptin research and their pivotal role in advancing pharmaceutical science and drug development. These methods serve as indispensable tools in ensuring the safety, efficacy, and quality of pharmaceutical products, ultimately benefiting patients worldwide. As pharmaceutical research continues to evolve, the ongoing development and validation of precise and reliable bioanalytical methods remain at the forefront of scientific progress, shaping the future of drug discovery and therapeutic advancements.

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Table No -1 : (Advantages and limitations of Various Bio-Analytical techniques)

Analytical Technique	Fundamental Principles	Linagliptin-Specific Attributes	Advantages	Limitations	References
High-Performance Liquid Chromatography (HPLC)	Separation of components based on differences in their affinity for a stationary phase (column) and a mobile phase (solvent)	Detects Linagliptin and its metabolites based on their retention times and UV absorption	High sensitivity, widely applicable, good reproducibility	Limited specificity, may require derivatization	[23],[24], [25]
Liquid Chromatography-Mass Spectrometry (LC-MS)	Separation of compounds by chromatography followed by mass spectrometric detection	Measures Linagliptin's molecular mass and fragmentation patterns	High sensitivity, specificity, and selectivity	Requires expensive instrumentation, expertise	[26],[27], [28]
Gas Chromatography (GC)	Separation of volatile compounds based on their vapor pressure	Less applicable to Linagliptin due to its limited volatility	Excellent resolution, sensitivity, and precision	Limited suitability for non-volatile compounds	[29],[30], [31]
Gas Chromatography (GC)	Separation of volatile compounds based on their vapor pressure	Less applicable to Linagliptin due to its limited volatility	Excellent resolution, sensitivity, and precision	Limited suitability for non-volatile compounds	[29],[30], [31]
Nuclear Magnetic Resonance (NMR)	Measures nuclear properties of atoms within a molecule	Detects Linagliptin based on its unique proton and carbon signals	Non-destructive, provides structural information	Lower sensitivity compared to MS and HPLC	[32],[33], [34]

Table 2: Steps Involved in Developing Analytical Methods for Linagliptin Analysis

Sl No.	Step	Description	Reference
1.	Method Selection	Choose an appropriate analytical technique (e.g., HPLC, LC-MS) based on the nature of the sample and the goals of the analysis.	[35]
2.	Solvent Selection	Optimize the choice of solvents for sample preparation, mobile phase, and dilution. Balance solubility and separation efficiency.	[36]
3.	Sample Preparation	Develop a sample preparation method (e.g., extraction, filtration) to extract Linagliptin from the sample matrix. Optimize extraction solvents and conditions.	[37]
4.	Chromatographic Separation	Select an appropriate chromatographic column (e.g., C18) and develop a mobile phase system. Optimize mobile phase composition, pH, and flow rate.	[38]
5.	Detection Method	Choose a suitable detector (e.g., UV, MS) and optimize detection parameters (e.g., wavelength, ionization mode) for Linagliptin.	[39]
6.	Calibration Standards	Prepare Linagliptin calibration standards covering the desired concentration range. Validate the linearity of the calibration curve.	[40]
7.	Method Validation	Perform method validation according to regulatory guidelines (e.g., FDA, EMA) to assess specificity, accuracy, precision, linearity, and robustness.	[36]



Amrit Kumar Rath *et al.*,**Table 3: Optimization Strategies for Linagliptin Analysis**

Sl No.	Optimization Aspect	Description	Reference
1.	Column Selection	Evaluate different chromatographic columns (e.g., C18, C8) for optimal separation. Consider column dimensions and particle size.	[41]
2.	Detector Optimization	Fine-tune detector settings, such as wavelength (UV) or mass spectrometric parameters (MS), to enhance Linagliptin signal and selectivity.	[42]
3.	Operating Conditions	Adjust operating conditions (e.g., temperature, pressure) for HPLC or LC-MS to optimize peak shape, resolution, and sensitivity.	[43]

Table No-4: Preferable Parameter For Analysis By LC-MS.

Sl No.	Parameter	Initial Value	Optimized Value	Optimization Method	Impact on Analysis
1	Mobile Phase Composition (ACN:H ₂ O)	70:30	60:40	Gradient elution	Improved peak shape and resolution
2	Mobile Phase pH	3.0	3.5	Adjusted with formic acid	Enhanced ionization efficiency
3	Flow Rate (mL/min)	0.3	0.4	Gradually increased	Reduced analysis time
4	Column Temperature (°C)	25	35	Incremental adjustments	Improved peak symmetry
5	Injection Volume (μL)	5	10	Optimization of sample loading	Increased sensitivity
6	Ionization Mode	ESI+	ESI+	Standard mode	Retained optimal ionization
7	Capillary Voltage (kV)	4.5	4.0	Adjusted within the range	Optimal ionization
8	Collision Energy (eV)	20	30	Collision-induced dissociation	Enhanced MS/MS signals

Table No 5 : Parameters for Method Validation in Pharmaceutical Analysis

Validation Parameter	Description	Reference
Specificity	Determines whether the method can differentiate Linagliptin from other components in the sample matrix.	ICH Q2(R1) Guideline [44]
Accuracy	Measures the closeness of test results to the true or reference values (recovery of Linagliptin).	USP General Chapter <1225> [45]
Precision	Assesses the repeatability and intermediate precision of the method (intra-day and inter-day precision).	USP General Chapter <1225> [45]
Linearity	Evaluates the ability of the method to produce results that are proportional to the Linagliptin concentration within a specified range.	ICH Q2(R1) Guideline [44]
Robustness	Demonstrates the method's reliability when slight variations in experimental conditions occur.	ICH Q2(R1) Guideline [45]



Amrit Kumar Rath *et al.*,**Table 6: Validation Parameters for Linagliptin Analysis and Preferred Parameters**

Validation Parameter	Description	Preferred Parameters	Reference
Specificity	Linagliptin should not cross-react with other components in the sample.	Chromatographic separation and MS selectivity.	ICH Q2(R1) Guideline [44]
Accuracy	Linagliptin recovery should be close to 100% of the expected value.	Accuracy within $\pm 15\%$ of the true value.	USP General Chapter <1225> [45]
Precision	Precision should be demonstrated by low %RSD for replicate measurements.	%RSD < 15% for intra-day and inter-day precision.	USP General Chapter <1225> [45]
Linearity	Calibration curve should show linearity over the desired concentration range.	Linear regression $R^2 > 0.99$.	ICH Q2(R1) Guideline [44]
Robustness	Method should be robust against small variations in conditions.	Minimal impact on results with minor variations.	ICH Q2(R1) Guideline [44]

Table 7: Case Studies on Successful Linagliptin Method Validation

Validation Parameter Focus	Validation Results	Reference
Specificity, Accuracy, Precision, Linearity, Robustness	Specificity confirmed, accuracy within $\pm 5\%$, precision %RSD < 2%, linear range 1-100 $\mu\text{g/mL}$, robust to small changes.	[46]
Specificity, Accuracy, Precision, Linearity	Specificity established, accuracy within $\pm 3\%$, %RSD < 1%, linear range 2-200 $\mu\text{g/mL}$.	[47]
Linearity, Robustness	Excellent linearity ($R^2 = 0.999$), robustness to minor changes in temperature and pH.	[42]

Table No 8: Recommendation for Selection of Instrumentation as per Characteristics

Meth od	Sensitiv ity	Speed	Cost- Effectiven ess	Applicability to Formulations/Ma trices	Strength s	Weaknesses	Recommend ation for Specific Scenarios	Refere nce
HPLC -UV	Moderat e	Moderat e	Cost-effective	API, Tablets, Oral Solutions	Robust, widely available, cost-effective	Limited sensitivity, longer analysis time	Suitable for routine quality control and API analysis.	[48]
LC-MS/M S	High	Fast	Moderate	API, Tablets, Biological Matrices	High sensitivit y, fast analysis, broad applicabi lity	Expensive instrumenta tion, method complexity	Ideal for pharmacokin etic studies and biological samples.	[49]
NMR	Low (for	Slow	Expensive	API, Solid-State	Structura l	Limited sensitivity,	Useful for solid-state	[50]



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	API)				informati on, non- destructi ve	time- consuming, expensive	characterizati on.	
LC- MS	High	Moder ate	Moderate	API, Tablets, Biological Matrices	High sensitivit y, broad applicabi lity	Moderate speed, requires MS instrument	Suitable for qualitative and quantitative analysis.	[51]
GC	Low	Fast	Cost- effective	API, Volatile Compounds	Fast analysis, cost- effective, suitable for volatiles	Limited applicability to non- volatile compounds	Recommende d for volatile compound analysis.	[52]





Partial Characterisation, Lipid Peroxidation Inhibition and Antiradical Activities of Peptides Isolated from the White Flowers of *Nelumbo nucifera*

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ABSTRACT

The objectives of the present study are to isolate the Cu(II) ninhydrin positive compounds (small alpha peptides) from the white petals of *Nelumbo nucifera* using circular paper chromatography, to confirm the peptide nature of these compounds using UV spectrophotometry, to evaluate the in vitro antioxidant activity of the small alpha peptides isolated from the white petals of *Nelumbo nucifera* and to study the invitro inhibition of lipid peroxidation of the small alpha peptides isolated from the white petals of *Nelumbo nucifera* using egg yolk. The novel peptides were isolated from the white petals of *Nelumbo nucifera* using inexpensive paper chromatography technique. The isolated peptides were studied for in vitro antioxidant activities. In vitro antioxidant studies showed that the peptides are free radical scavengers and the radical scavenging activity increases with increase in concentration of the peptides. A simple and inexpensive paper chromatographic method was developed, with the use of Cu(II) ninhydrin reagent, for the production and detection of small alpha peptides from the white petals of *Nelumbo nucifera*. The peptide nature was confirmed using UV-VIS spectrophotometry. The inhibition of lipid peroxidation and antiradical activities of the peptide isolated were evaluated using invitro methods and the isolated peptide showed efficient antioxidant properties.

Keywords: Alpha peptides, *Nelumbo nucifera*, Cu(II) ninhydrin reagent, chromatography, free radicals.





INTRODUCTION

A medicinal plant is any plant which, in one or more of its organs contains substances that can be used for therapeutic purpose or which are precursors for the synthesis of useful drugs. This description makes it possible to distinguish between medicinal plants whose therapeutic properties and constituents have been established scientifically, and plants that are regarded as medicinal but which have not yet been subjected to a thorough scientific study. A number of plants have been used in traditional medicine for many years. Some do seem to work although there may not be sufficient data to confirm their efficacy. Such plants should qualify as medicinal plant. The term "Crude drugs of natural or biological origin" is used by pharmacists and pharmacologists to describe whole plants or parts of plants which have medicinal properties [1].

COPPER (II) NINHYDRIN

A Cu^{2+} -ninhydrin reagent was used to distinguish qualitatively small α -peptides and α -amino acid amides from free amino acids on paper after chromatography. With the exception of peptides containing N-terminal L-tryptophan, all the peptides gave a yellow chromophore with a λ_{max} at 395 nm. Protein and non-protein amino acids and polyamines gave different chromophores which varied from one compound to another. Peptides with N-terminal L-proline gave a very faint yellow chromophore or no coloured product at all, while glutathione, a γ -glutamyl peptide, gave a red colour. Polypeptides and proteins did not produce a yellow chromophore. Evidence is provided for a reaction sequence in which peptides first react with Cu^{2+} to form a complex which then reacts with ninhydrin to give the yellow chromophore. [2] Antioxidants are man-made or natural substances that may prevent or delay some types of cell damage. Diets high in vegetables and fruits, which are good sources of antioxidants, have been found to be healthy; however, research has not shown antioxidant supplements to be beneficial in preventing diseases. Examples of antioxidants include vitamins C and E, selenium, and carotenoids, such as beta-carotene, lycopene, lutein, and zeaxanthin. This fact sheet provides basic information about antioxidants, summarizes what the science says about antioxidants and health, and suggests sources for additional information. Antioxidant molecules have been shown to counteract oxidative stress in laboratory experiments. [3] Lotus (*Nelumbo nucifera*) is a perennial aquatic basal eudicot belonging to a small family *Nelumbonaceae*, which contains only one genus with two species.

It is an important horticultural plant, with its uses ranging from ornamental, nutritional to medicinal values, and has been widely used, especially in Southeast Asia. Recently, the lotus obtained a lot of attention from the scientific community. [4] The technique of circular paper chromatography was used in the analysis of free amino acid constituents or proteins and peptides in *Enteromorpha polifera*, *F.capillaris* and *Ulva lactua var rigida*. The technique may be employed for screening and isolation of Cu (II) ninhydrin positive compounds from petals of white flowers which proves to be simple and easy. From the preparative aspect, the conventional paper chromatographic technique is rather limited, in that only a few micrograms of material can be spotted on a single strip or sheet, and the labour involved in the separation of even milligram quantities in this way is enormous. From this point of view the circular paper chromatographic technique offers great possibilities.[5]The plant selected for the present study are less used by researchers and hence studies on these plants would help reveal the medicinal and other properties on them. The objectives of the present study are to isolate the Cu(II) ninhydrin positive compounds (small alpha peptides) from the white petals of *Nelumbo nucifera* using circular paper chromatography, to confirm the peptide nature of these compounds using UV spectrophotometry, to evaluate the in vitro antioxidant activity of the small alpha peptides isolated from the white petals of *Nelumbo nucifera*, to study the invitro inhibition of lipid peroxidation of the small alpha peptides isolated from the white petals of *Nelumbo nucifera* using egg yolk.





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MATERIALS AND METHODS

PREPARATION OF CRUDE EXTRACT

1g of white petals of *Nelumbo nucifera* were homogenized thoroughly, with a mortar and pestle for approximately 5 min, in 5ml of warm (60°C) 80% aqueous ethanol. The ethanol extract was filtered through a Whatman No.1 filter paper. The filtered extract was centrifuged at 3000 rpm for 10 min. The clear supernatant thus obtained was used as the crude source of the small peptide.(6)

CIRCULAR PAPER CHROMATOGRAPHY

The flower extract was spotted in the center of Whatman No.1 filter paper. Depending upon the number samples to be analyzed the paper may be demarcated. The diameter of the sample spotted was restricted to 0.5cm by intermittent use of hot air dryer. The sample spotting may be repeating 15 to 20 times to ensure sufficient concentration of the component to be detected. The chromatography was carried in an isopropanol: water (4:1,v/v) solvent system by connecting a filter paper wick to the solvent through a hole made at the center of the circular paper.

PURIFICATION OF ALPHA PEPTIDES :

To subject the compound for various structural studies a simple and inexpensive purification procedure was followed. Five or more circular paper chromatograms of the flower extract were run simultaneously using Whatman No.1 filter paper discs (12cm). One of them was developed with and eluted by soaking in 80% ethanol. The compound thus obtained from *Nelumbo nucifera* was used for conducting the structural studies.(7)

UV VISIBLE SPECTROPHOTOMETRY

The purified flower extract of *Nelumbo nucifera* was studied for its absorption spectrum in ultra-violet visible spectrophotometer (SHIMADZU). UV/VIS involves the spectroscopy of photons in the UV-visible region. it uses light in the visible and adjacent near ultraviolet (UV) and near infrared (NIR) ranges. In this region of the electromagnetic spectrum, molecules undergo electronic transitions. The basic parts of the spectrophotometer are a light source (often an incandescent bulb for the visible wavelengths, or a deuterium arc lamp in the ultraviolet), a holder for the sample, a diffraction grating or a monochromator to separate the different wavelengths of light and a detector. The detector is typically a photodiode or a CCD. It measures the intensity of light passing through a sample (I), and compares it to the intensity of light before it passes through the sample (I_0). The UV region scanned is normally from 200 to 400nm and the visible portion is from 400 to 800nm.(8)

SAMPLE PREPARATION FOR ANTIOXIDANT ASSAYS

The Cu(II) ninhydrin positive compounds isolated from the petals of *Nelumbonucifera* using paper chromatography were evaporated to dryness at room temperature and dissolved in minimum quantity of distilled water, and then used for antioxidant assays.

COLORIMETRIC DETERMINATION OF CONCENTRATION OF THE Cu(II) NINHYDRIN POSITIVE COMPOUNDS

1ml of the purified Cu(II) ninhydrin positive compound was added with 1ml of Cu(II) ninhydrin reagent and the mixture was incubated at 40°C for 5 min. The yellow color produced was read at 420nm. The amount of these compounds were determined by using a standard graph constructed with L-glycyl glycine as the standard.(9)

ASSAY OF ANTIOXIDANTS

DPPH RADICAL SCAVENGING ACTIVITY

The method described by Liyana-Pathiranan and Shahidi was used in this assay. 1 ml of the extracts or the standards at different concentrations, prepared in triplicates, was mixed with 1 ml of DPPH (0.135 mM) prepared in methanol. The mixtures were vortexed thoroughly and left in the dark for 30 min at room temperature. The absorbance was



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then measured spectrophotometrically at 517 nm. The percentage of DPPH scavenging activity of the extract or standard was calculated with the following formula: % DPPH radical scavenging activity = $[(AC-AS)/AC] \times 100$, where AC is the absorbance of the control and AS is the absorbance of the test samples (extract or standard). (10)

ASSAY OF SUPEROXIDE RADICAL SCAVENGING ACTIVITY

The extent of superoxide generation was studied on the basis of inhibition in the production of nitroblue tetrazolium formazon (NBT) of the superoxide ion by the plant sample measured colorimetrically at 560nm. 0.5ml of the extract with different concentrations was mixed with 0.2ml of EDTA, 0.1ml of NBT, 0.05ml of riboflavin and 2.55ml of phosphate buffer. 0.1ml of DMSO was taken and the reagents were added in the similar manner and were treated as control. The absorbance was measured at 560nm. (11)

REDUCTION POTENTIAL

The reduction potential is the detected on the basis of the ability of antioxidants to form coloured complex with potassium ferricyanide, TCA and ferrous chloride. The colour produced was measured at 700nm. 1ml of the extract with different concentrations was mixed with 2.5ml of 1% potassium ferricyanide and 2.5ml of phosphate buffer pH6.6. The mixture was incubated at 50°C for 20 minutes. After incubation 2.5ml of 10% TCA was added to it and centrifuged at 3000rpm for 10 minutes. 2.5ml of supernatant was taken; 2.5ml water and 0.5ml 0.1% ferric chloride were added to it. The absorbance of the reaction indicated the reducing power of polyphenol test samples. (12)

ABTS(2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonicacid)] Radical Scavenging Assay

ABTS decolourisation assay involves the generation of the ABTS chromophore by the oxidation of ABTS with ammonium persulphate. It is applicable for both hydrophilic and lipophilic compounds. The scavenging activity of the test samples on ABTS radical cation were measured at 734nm. This assay was performed according to the method of adedapo ethal. It is based on the reaction between ABTS and potassium persulfate; to procedure the ABTS radical cation (ABTS's), a bluish-green chromogen. Which is converted to a colourless solution in the presence of an antioxidant reductant. A working solution was prepared by mixing equal amount of 7Mm ABTS and 2.4Mm potassium persulfate. These were allowed to react for about 12hours in the dark at room temperature 1ml of the resulting solution was mixed with 60ml methanol and the absorbance was adjusted to 0.706 ± 0.001 units at 734nm. By addition of drops of the original ABTS / potassium persulfate solution. Thereafter, 1ml of each extract and the standard prepared at the different concentration (0.025-0.50mg/ml in the methanol was mixed with 1ml of the ABTS) methanol solution. The absorbance of the resulting solutions was read at 734nm after about 7mins. ABTS radical scavenging activity was indicated by different degrees of decolorization of the dark green colour of the ABTS solution. All the assays were done in triplicate. (13) The percentage of ABTS radical scavenging activity was calculated from the following equation:

ABTS radical cation scavenging assay [%] = $[(\text{Absorbance of control} - \text{Absorbance of test}) / \text{Absorbance of control}] \times 100$.

INVITRO LIPID PEROXIDATION ASSAY

The anti-lipid peroxidative properties of aqueous extracts were studied by a method . In brief the egg yolk was weighed to 1 g and diluted to 100 ml with 100mM Tris-HCl, pH 7.4 and used as homogenate. The homogenate was incubated with Fe (II) or sodium nitroprusside with or without the extract and colour reaction was carried out by adding 600 µl of TBA and 600 µl of acetic acid (pH 3.4) for 1 h. The tubes were cooled and 2 ml of n-butanol was finally added and centrifuged. The absorbance was read at spectrophotometer at 532 nm. (14)

RESULTS AND DISCUSSION

In our preliminary studies as a part of screening process for Cu(II) Ninhydrin positive compounds in flowers of medicinal value, the following results were obtained.





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DAISY ASTERACEAE : NEGATIVE

DAFFODIL NARCISSUS : NEGATIVE

NELUMBO NUCIFERA: POSITIVE

The Cu(II) – ninhydrin positive compounds which may be a small peptide, an amino acid amide or an amino acid ester [14] were purified from the flowers of *Nelumbo nucifera*. The peptide nature of the purified compound was established by scanning the compound in the UV – VIS spectrophotometer (SHIMADZU) from 200 nm to 900 nm. A single sharp peak at or around 210 nm was obtained indicating the presence of peptide bond in the compound. [15] A peak at or around 210 nm indicates the presence of a peptide bond in the compound.

ASSAY OF ANTIOXIDANTS

DPPH RADICAL SCAVENGING ACTIVITY

DPPH is a stable free radical that shows a maximum absorption at 570nm. When DPPH encounters proton donating substances such as an antioxidant and a radical species, the absorbance at 570nm disappears because the DPPH radical is scavenged. [16] On the basis of this principle, the radical scavenging effect of different concentrations (50µg/ml, 100µg/ml, 500µg/ml and 1000µg/ml) of isolated peptide were measured with ascorbic acid as the standard. Significant radical scavenging effect was found in the isolated peptide samples.

SUPEROXIDE RADICAL SCAVENGING ASSAY

Superoxide radical is involved in many pathological conditions. It mediates inflammatory tissue injuries in ischaemia –reperfusion, arthritis, gout, gastric ulceration [17] In the present study, the peptide isolated from *Nelumbo nucifera* were checked for their inhibitory effect on superoxide production. The peptides showed increase in antioxidant activity with increase in concentration.

REDUCTION POTENTIAL

Reducing power is to measure the reductive ability of antioxidant, and it is evaluated by the transformation of Fe (III) to Fe (II) in the presence of the sample extracts. The reducing ability of a compound greatly depends on the presence of reductones, which exhibit antioxidative potential by breaking the free radical chain by donating a hydrogen atom. The results showed that reducing power of *Nelumbo nucifera* peptides. (18)

ABTS(2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonicacid)) Radical Scavenging Assay

ABTS radical scavenging activity was positively correlated to the concentration of the extract. In this analysis, the *Nelumbo nucifera* peptides showed higher radical scavenging activity of ABTS.

LIPID PEROXIDATION

Anti-lipid peroxidation activity is determined using TBARS assay over the peptides isolated from *Nelumbo nucifera*. The result expressed in graph. The inhibition of lipid peroxidation activity in *Nelumbo nucifera* showed with the IC₅₀ value. (19)

CONCLUSION

From the results obtained in our experiments we have concluded the following. Presence of Cu (II) – ninhydrin positive compounds in the flowers medicinal plants. They may small peptides, amino acid amides or amino acid esters. The peptide nature of the extract was confirmed using UV spectroscopy. The extracted peptides showed significant antioxidant activity and inhibition of lipid peroxidation.

STATEMENTS AND DECLARATIONS

Ethical Approval

Not applicable

Consent to participate

The authors declare their consent to participate in the publication





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Consent to publish

The authors declare their consent to publish the manuscript

Authors Contributions

All authors (Dr.Rajeswari Prabha Mahendran and Ms.Krithika) have contributed equally and all authors read and approved the final manuscript.

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Competing interests

The authors have no relevant financial or non- financial interests to disclose.

Availability of data and materials

All the datas will be made available on request.

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Table -1 DPPH ASSAY

CONCENTRATION ($\mu\text{g/ml}$)	ASCORBIC ACID (% Inhibition)	PEPTIDE ISOLATED FROM <i>Nelumbo nucifera</i> (% inhibition)
50	87.5	16.6
100	89.1	34.7
500	90.9	54.5
1000	92.8	76.1
Ic50 values($\mu\text{g/ml}$)	233.45	964.225

Table-2 SUPER OXIDE ASSAY

CONCENTRATION ($\mu\text{g/ml}$)	ASCORBIC ACID (% Inhibition)	PEPTIDE ISOLATED FROM <i>Nelumbo nucifera</i> (% inhibition)
50	84.21	21.05
100	86.11	22.22
500	88.23	29.41
1000	90.62	31.25
Ic50 values($\mu\text{g/ml}$)	242.08	937.60

Table- 3 REDUCTION POTENTIAL

CONCENTRATION	ABSORBANCE
50	1.09
100	1.16
500	1.90
1000	2.69

Table – 4 ABTS ASSAY

CONCENTRATION ($\mu\text{g/ml}$)	ASCORBIC ACID (% Inhibition)	PEPTIDE ISOLATED FROM <i>Nelumbo nucifera</i> (% inhibition)
50	90.9	63.6
100	83.3	58.3
500	76.9	42.30
1000	71.42	28.57
Ic50 values ($\mu\text{g/ml}$)	278.125	222.825





Table – 5 LIPID PEROXIDATION ASSAY

CONCENTRATION ($\mu\text{g/ml}$)	WITH PLANT EXTRACT (<i>Nelumbo nucifera</i>) (% Inhibition)	WITHOUT PLANT EXTRACT (% inhibition)
50	42.85	14.2
100	41.6	13.8
500	40.5	14.86
1000	39.4	15.7
Ic50 values ($\mu\text{g/ml}$)	60.9	170.90



Figure 1: Circular chromatogram of flower extracts of *Nelumbo nucifera* sprayed with Cu (II)ninhydrin reagent . It shows yellow coloured compound obtained from these extracts.

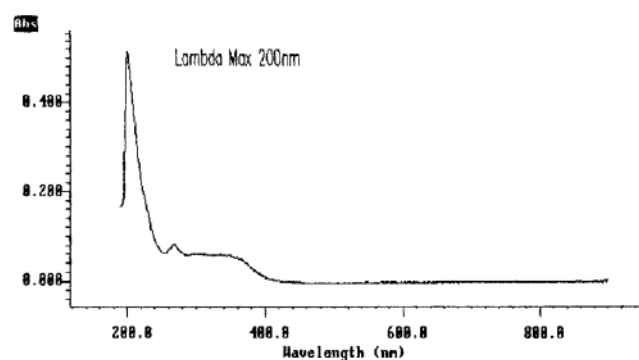


Figure 2: Absorption Spectrum Of The Purified Compound From *Nelumbo nucifera*





RESEARCH ARTICLE

Phytochemical Profiling, *In vitro* Antimicrobial Activity of *Terminalia arjuna* Bark Extracts

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ABSTRACT

In the present study, we investigated the anti-microbial capabilities of *Terminalia arjuna* bark extracts from different solvents and investigated the main component responsible for these biological effects. *Terminalia arjuna* bark is extracted from several solvents, namely Petroleum benzene, Benzene, Chloroform, Ethanol, and Water. High concentrations of alkaloids, phenolic chemicals, and flavonoids were present in the petroleum benzene and chloroform extracts. There were 75 phytochemicals derived from different solvent extracts, based on the GC-MS study. The phytochemical Dicyclohexyl phthalate was obtained from the chloroform extract by Silica gel column chromatographic separation. The isolated compound was characterized by IR, NMR, mass spectroscopy, and elemental analysis. The agar diffusion method was used to evaluate dicyclohexyl phthalate antibacterial activity against *Enterococcus faecalis*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Aspergillus niger*, and *Candida albicans*. The pathogens *Klebsiella pneumoniae* (16 mm) and other pathogens have an impact that is comparable to that of the reference medications in terms of antibacterial activity.





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Keywords: *Terminalia arjuna* bark, GC-MS Analysis, Dicyclohexyl phthalate, Spectrometric analysis, Anti-microbial activity.

INTRODUCTION

Multiple drug resistance has developed against many microbiological infections in the modern world as a result of the widespread, indiscriminate use of commercial antimicrobial drugs frequently used in the treatment of infectious diseases[1]. Antibiotics can also occasionally have negative side effects on the host, such as hypersensitivity, immunological suppression, and allergic reactions, in addition to this issue. Therefore, it is necessary to develop alternative medicinal plant-based antibacterial drugs for the treatment of infections[2]. The most bioactive chemical compounds from plants with significant antimicrobial properties were phenolics, alkaloids, flavonoids, triterpenes, and steroids[3,4]. The plant *Terminalia arjuna*, which belongs to the Combretaceae family, is well known for having a rich phytochemical profile. It has a number of bioactive components, including triterpenoids, tannins, steroids, flavonoids, and polyphenols as well as saponin. One of the most important medicinal species from this genus, it is utilised extensively in traditional medicine[5,6]. The fresh or dried leaves, roots, bark, and flowers of the *Terminalia arjuna* plant are all used in Ayurvedic medicine. The powdered leaves have numerous uses, including aiding in the quick healing of wounds, acting as a purgative, treating liver issues, promoting sexual health, relieving headaches and stomachaches, and applying to sprains to lessen discomfort and swelling. The dried leaves are used to treat rheumatic pain, paralysis, and as an anti-inflammatory and expectorant.

As a remedy for snake poisoning, dried latex and roots are utilised. Additionally, it is used as an abortifacient to cure intestinal worms and piles. Additionally, migraines are treated with the tender leaves[7]. The bark of *Terminalia arjuna* can be used to treat a variety of ailments, including diarrhoea, ulcers, vata, fractures, leucorrhoea, haemorrhages, bronchitis, cardiopathy, cough, verminosis, gonorrhoea, and burning pain[8,9]. This enormous tree is widespread throughout South East Asian nations' deciduous woods. The plant is known as a "crocodile bark tree" because of its fissured and cracked bark, which makes it easy to identify. Numerous medical benefits are offered by this plant. The spectrum of benefits comprises antifungal, antidiabetic, anti-diarrheal, anti-hyperglycemic, anti-leucorrheal, antioxidant, anti-inflammatory, anti-microbial, anti-ulcer, anti-leucorrheal, and hepatoprotective properties [5,6,10,11]. Strong antibacterial activity has been demonstrated by *Terminalia arjuna* bark methanolic extract against two Gram-positive *S. aureus*, *S. mutans*, and two Gram-negative *E. coli* and *K. pneumoniae*, human pathogenic bacteria[12]. Plants produce a category of hydroxylated phenolic compounds known as flavonoids in response to microbial infection[13]. The two bacteria that the bark of *Terminalia chebula* has the most antibacterial action against are *S. typhi* (15 mm) and *E. faecalis* (14 mm)[14]. According to Natarajan D et al.[15], the extracts' alkaloids, phenolic chemicals, flavonoids, and tannins have strong antibacterial effects. *Escherichia coli*, *Klebsiella pneumoniae*, and *Staphylococcus aureus* antibacterial activity of *Terminalia catappa* L. barks extracted in methanol was compared. Compared to the leaf extracts, the bark extracts often displayed superior efficacy against the test organisms[16]. Therefore, the presence of flavonoids, tannins, saponins, steroids, and terpenoids may be the cause of this medicinal plant's antibacterial effect[17,18,19]. In addition to the abovementioned fact, we tested the bark extracts of *Terminalia arjuna* against pathogenic bacteria and fungus in order to find novel sources of antibacterial agents. The antibacterial and antifungal properties of several solvent extracts made from *T. arjuna* bark, as well as an isolated compound, are discussed in this work.

MATERIALS AND METHODS

General

Using an FT-IR Agilent Cary 630 spectrophotometer, IR spectra of the isolated phyto compound dicyclohexyl phthalate have been recorded in the 4000-400 cm⁻¹ region. The ¹H and ¹³C spectra were measured in CDCl₃



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solution using a Bruker Avance II 400/AvIII HD-300 spectrometer. On a Waters Alliance e2695/HPLC-TQD mass spectrometer in CDCl₃ solution, electrospray ionization mass spectrometry (ESI-MS) data were collected. The Elemental Analysis was recorded using a EuroVector E 3000 Elemental Analyser.

Collection of Plant Material

In the months of October and November 2022, bark from *Terminalia arjuna* was collected in the Tamilnadu village of Kasilingapuram (8°46'38.7"N 77°52'50.6"E). Dr. C. Babu, Head and Associate Professor of Botany at Pioneer Kumaraswamy College in Nagercoil, has identified and verified plant specimens. The barks were properly cleaned under running water to remove any dust before being dried in the shade for 7-8 days at room temperature. The plant bark was then reduced to a powder and kept for future use in an airtight container.

Extract Preparation

The extracts were made using 50 g of dried bark, 250 mL of petroleum benzine (40-60°C), benzene, chloroform, ethanol, water, and a soxhlet extractor. The extracts were kept at room temperature in an airtight container to allow the solvent to evaporate. The mixture was refrozen and kept at 4°C for later use[20,21].

Phytochemical Analysis

The bark of *Terminalia arjuna* has been analysed for phytochemicals using the earlier method[22]. Various qualitative methods of analysis were used to determine the chemical component profiles of the extracts. Several solvents are often used to remove the unprocessed powder, and the resulting mixture is then tested to see which phytoconstituents are present. The most usually tested substances include terpenoids, steroids, phenolic compounds, alkaloids, saponins, and flavonoids.

Gas Chromatography-Mass Spectrum (GC-MS) Analysis

We evaluated the phytochemistry of *Terminalia arjuna* using GC-MS analysis at Bishop Heber College's Heber Analytical Instrumentation Facility (HAIF), Trichy-620 017. In this study, the gas chromatography-mass spectrometry studies were carried out using the GC-MS system (GC MS QP2020; SHIMADZU), which is made up of an autosampler, an injector, a gas chromatograph (GC-2010), and a mass spectrometer. The GC-MS system employed a capillary standard non-polar column SHRxi-5Sil-MS with the following characteristics: 30.0 m, 0.25 mm diameter, and 0.25 m film thickness. An electron ionisation system was put into place with a 70 eV electron ionisation energy. 5 L of injection volume and 1.20 mL/min of gas with a 99.99 percent helium content (split ratio: 10) were used. It was planned for the oven's temperature to begin at 50°C (isothermal for 2 min.) and increase to 280°C over the course of 10 min. Mass spectra were captured at 70eV with a scanning interval of 0.3 seconds and a scan range of 50-500 m/z. The entire running time of the GC was 21 minutes. We calculated the percentage of each component by dividing the average peak area of each component by the total peak area. To examine mass spectra and chromatograms, we used the real-time software system for the Shimadzu GC-MS.

Identification of components

The National Institute of Standards and Technology's (NIST's)[23] (NIST) and WILEY's[24] (WILEY) data, which contain more patterns, were used to examine GC-MS mass spectra. In the NIST and WILEY libraries, the spectra of the unknown component and those of the recognised components were compared. Each component of the test substance had its name, structure, molecular weight, and molecular formula recorded.

In-vitro antimicrobial activity

Standard sterilized filter paper discs (5 mm diameter) impregnated with a solution of the test compound in DMSO (1 mg/mL) was placed on an agar plate seeded with the appropriate test organism in triplicates. All the plant extracts were evaluated for their in vitro antibacterial activity against *Enterococcus faecalis*, *Staphylococcus aureus* as examples of Gram-positive bacteria and *Klebsiella pneumonia*, and *Pseudomonas aeruginosa* as examples of Gram-negative bacteria. They were also evaluated for their in vitro antifungal potential against *Aspergillus niger*, *Candida albicans* fungal strains. Agar-diffusion method was used for the determination of the preliminary antibacterial and antifungal



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activity. Amoxicillin and Fluconazole were used as reference drugs. DMSO alone was used as a control at the above-mentioned concentration. The plates were incubated at 37°C for 24 h for bacteria and 28°C for 48 hr for fungi[25].

RESULTS AND DISCUSSION

Qualitative phytochemical analysis of *Terminalia arjuna* bark extracts

Due to certain substances that have a significant physiological effect on microbial, plants have a bioactive value. The alkaloids, terpenoids, steroids, and phenols are the most significant of these substances. Table 1 displays the qualitative phytochemical analysis of various *Terminalia arjuna* bark extracts.

GC-MS Analysis of *Terminalia arjuna* Barks extract

Using GC-MS, it is possible to identify the functional groups that make up the bioactive components of terpenoids, steroids, phenolic compounds, alkaloids, saponins, and flavonoids. In this study, we examine the Gas Chromatography-Mass Spectroscopy findings on the different *Terminalia arjuna* solvent extracts, as indicated in (Table 2) and (Figure 1).

In-vitro Antimicrobial evaluation

Terminalia arjuna extracts isolated compounds Dicyclohexyl phthalate was tested for their in vitro antibacterial activity against Gram-positive bacteria like *Enterococcus faecalis* and *Staphylococcus aureus*, Gram-negative bacteria like *Klebsiella pneumonia* and *Pseudomonas aeruginosa*. Additionally, they were tested for their *in vitro* antifungal effectiveness against *Aspergillus niger* and *Candida albicans* fungus strains. To determine the preliminary antibacterial and antifungal activities, the agar-diffusion method was performed. As reference drugs, amoxicillin and fluconazole were employed. The average diameter of the inhibition zones (IZ) of bacterial or fungal growth encompassing the discs, measured in millimetres, was used to represent the results for each tested drug, and these values are listed in Table 3.

DISCUSSION

The results of the phytochemical investigation showed the presence of phenolic, terpenoid, steroid, and alkaloid components. Terpenoids were concentrated in significant quantities in the petroleum benzene extract but not as much in the chloroform or ethanol extracts. High concentrations of steroids, alkaloids, phenolic compounds, and flavonoids were found in ethanol extracts. A significant amount of phenolic compounds, alkaloids, and tannins were found in the water extracts. In petroleum benzene benzene and chloroform extracts, the carbohydrate steroids and glycoside have been shown to be present in very low concentrations. Various substances were found in the extracts during the phytochemical analysis, including reducing sugar, steroids, phenolic compounds, flavonoids, terpenoids, alkaloids, saponins, and glycosides. In all extracts, carbohydrates were found in moderate amounts. Significant amounts of tannins, saponins, flavonoids, and phenolic substances were present in both the ethanolic and water extracts. All extracts included a small amount of steroids. All extracts had only trace amounts of glycosides, although the ethanol and water extracts had very low concentrations of reducing sugar. The results of the current investigation are consistent with those from their preliminary phytochemical screening of *T. tomentosa* stem bark using methanolic extract, which was done in their work[26]. Researchers[5] who studied the ethanolic extract of the stem bark of *T. tomentosa* Rox (ex DC) Wight & Arn and conducted a phytochemical examination on it noted comparable outcomes. Seven of the compounds found in the petroleum benzene extract have been demonstrated to have microbiological characteristics, making the total number of chemicals in the extract fifteen: (3E)-7,7-dimethylnona-1,3,8-trien-5-one(2.24), 1-BOC-5-methoxyindole(1.12), 1-Furfurylpyrrole(3.12), 2-Neopentyl-1,3-benzoxazole(1.16), 4-Methyl-1-phenyl-1,3-pentanedione(2.75), Bis(2-ethylhexyl)phthalate(31) and trifluoromethanesulfonic anhydride(1.48). The benzene extract contains fifteen different compounds, two of which, 1-tert-butyl-4-methylenecyclohexane (1.59) and 4-Ethyl-3-methylenedihydrofuro[3,4-b]furan-2,6(3H,4H)-dione (1.45), are effective against microorganisms. Four of





the twenty-five chemicals present in chloroform extract are effective antimicrobials. These include Trans-2-nonen-1-ol (2.31) and Dicyclohexyl phthalate (1.36) as well as 1,3,5-Triazine (0.31), 2,5-Dimethyl-1,3,5-dithiazine (1.5), and 1,3,5-Triazine (0.31). The ethanol extract contains twenty different chemicals, three of which are antimicrobial, such as Tetracyanopyrrole (3.14), Pentadecane (2.87), and 3-Nitrophthalic acid (0.14). Twenty different substances were found in the water extract, and 2,4-Dimethyl-3-pentanol, which was one of them, was an antibacterial compound (0.76). The Dicyclohexyl Phthalate Compounds Isolated from the *Terminalia arjuna* Bark Chloroform Extract. The dried bark chloroform extract of *Terminalia arjuna* (1 g) was subjected to silica gel flash column chromatography and eluted with an increasing gradient of ethyl acetate in n-hexane. A total of 15 fractions were collected (each 50 mL). Fraction 6 (eluted with 45% ethyl acetate) afforded dicyclohexyl phthalate (500 mg) as colourless powder. Its HRMS displayed [M]⁺ m/z peak at 330 (calculated 330 for the chemical formula C₂₀H₂₆O₄). The ¹H NMR spectrum showed two multiplet at δ 1.23 -2.17 (m, 20 H) attributed to methylene group in cyclohexyl group.

The cyclohexyl CH group was observed at δ 5.03, 2H, m-CH). In addition, a multiple at δ 7.26 and 7.71 (4H, m) showed peaks attributed to phenyl proton. (Figure 3). The ¹³C NMR, confirmed the presence of ester carbonyl carbon at δ 167.7, phenyl carbon at δ 132, 130.9, and 128.8, two -CH carbon at δ 74.21 and cyclohexyl methene methylene group at δ 23.95, 25.60 and 31.68. The following composition was found by the CHNS analysis: Hydrogen (H) accounts for 8.440% (7.930%) of the total, Oxygen (O) for 21.340% (19.370%), and Carbon (C) for 70.220% (72.70%). Based on the above spectroscopic evidence and comparison with spectral data of dicyclohexyl phthalate is found to be a new compound (Figures 2 & 3), reported herein for the first time. According to the results shown in Table 3, the majority of the tested plant extracts had varying inhibitory effects on the growth of the tested Gram-positive and Gram-negative bacterial strains as well as against antifungal strains. The activity of this Dicyclohexyl phthalate against Gram-negative bacteria was generally superior to Gram-positive bacteria. The results of the study on the structure activity relationship (SAR) of dicyclohexyl phthalate against broad spectrum antibacterial profile against the investigated organisms. According to our results, reference drugs Amoxicillin and Fluconazole were found to have superior antimicrobial effects to Dicyclohexyl phthalate against *Enterococcus faecalis*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Aspergillus niger* and *Candida albicans*. The *Klebsiella pneumoniae* pathogens has higher antimicrobial activity (16 mm) than the reference drug (13 mm).

CONCLUSION

Traditional uses for *Terminalia arjuna* include the treatment of fever, sore throat, cough, TB, asthma, sore throat, and skin diseases. The bark extracts of the aforementioned *Terminalia arjuna* were used in the current study to identify seventeen chemicals, the first isolation of which was Dicyclohexyl Phthalate. The antibacterial activity of the *Klebsiella pneumoniae* pathogens is greater (16 mm) than that of the reference drugs (13 mm). Our isolated compound dicyclohexyl phthalate may be a promising therapeutic candidate that is consistent with the known traditional use of the plants they investigated.

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Table 1. Preliminary phytochemical screening of extract of powdered barks of *Terminalia arjuna*

S.No	Phytochemicals	Solvents				
		Petroleum benzine	Benzene	Chloroform	Ethanol	Water
1	Terpenoids (Chloroform test)	-	-	-	-	-
2	Carbohydrates (Molisch's test)	++	++	++	++	++
3	Phenolic compounds (Ferric Chloride test)	-	-	-	+++	+++
4	Steroids (Chloroform test)	++	++	++	++	+
5	Saponin (Foam test)	-	-	-	+++	++
6	Alkaloids (Wagner's test)	-	-	++	+++	+++
7	Flavonoids (Alkaline reagent test)	-	-	-	++	++
8	Glycosides (Salkowski's test)	+	+	+	+	+
9	Tannins	-	-	-	+++	+++
10	Reducing sugar (Fehling's test)	-	-	-	+	+

Note: + → present in small concentration; ++ → present in moderately high concentration; +++ → present in very high concentration; - → absent

Table 2. Major phytochemicals in different solvent extracts *Terminalia arjuna* bark by GC-MS chromatogram

Solvent	Retention Time	Peak Area %	Name of the Compound	Molecular formula	Molecular weight	m/z value	Name of the phytochemicals
Petroleum benzine	39.014	2.24	(3E)-7,7-dimethylnona-1,3,8-trien-5-one	C ₁₁ H ₁₆ O	164	164	Trienone
	39.475	1.12	1-BOC-5-methoxyindole	C ₁₄ H ₁₇ NO ₃	247	247	Indole derivative
	39.475	3.12	1-Furfurylpyrrole	C ₉ H ₉ NO	147	147	Pyrrole
	39.705	1.16	2-Neopentyl-1,3-benzoxazole	C ₁₂ H ₁₅ NO	189	189	Benzoxazole derivative
	39.430	2.75	4-Methyl-1-phenyl-1,3-pentanedione	C ₁₂ H ₁₄ O ₂	190	190	Pentanones
	34.889	31	Bis(2-ethylhexyl)phthalate	C ₂₄ H ₃₈ O ₄	390	390	Phthalate ester
	39.52	1.48	Trifluoromethanesulfonic anhydride	C ₂ F ₆ O ₅ S ₂	282	282	Triflic acid
Benzene	40.160	1.59	1-tert-butyl-4-methylenecyclohexane	C ₁₁ H ₂₀	152	152	Cyclohexane derivative
	39.432	1.45	4-Ethyl-3-methylenedihydrofuro[3,	C ₉ H ₁₀ O ₄	182	182	Furazone derivative





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			4-b]furan-2,6(3H,4H)-dione				
Chloroform	39.96	0.31	1,3,5-Triazine	C ₃ H ₃ N ₃	81	81	Triazine
	38.134	1.5	2,5-Dimethyl-1,3,5-dithiazine	C ₅ H ₁₁ NS ₂	149	149	Triazine
	38.192	2.31	Trans-2-nonen-1-ol	C ₉ H ₁₈ O	142	142	Primary allylic alcohol
	37.64	1.36	Dicyclohexyl phthalate	C ₂₀ H ₂₆ O ₄	330	330	Phthalate ester
Ethanol	26.365	3.14	Tetracyanopyrrole	C ₈ HN ₅	167	167	Pyrrole derivative
	16.132	2.87	Pentadecane	C ₁₅ H ₃₂	212	212	Alkanes
	34.885	0.14	3-Nitrophthalic acid	C ₈ H ₅ NO ₆	211	211	Phthalic Acids
Water	37.395	0.76	2,4-Dimethyl-3-pentanol	C ₇ H ₁₆ O	116	116	Aliphatic alcohol

Table 3. In-vitro antimicrobial activity of dicyclohexyl phthalate against the Human pathogens

Pathogens	In-vitro antimicrobial activity (Zone of inhibition in mm)	Reference drug. (amoxicillin /fluconazole)
<i>Enterococcus faecalis</i>	16	17
<i>Staphylococcus aureus</i>	14	16
<i>Klebsiella pneumoniae</i>	16	13
<i>Pseudomonas aeruginosa</i>	11	14
<i>Aspergillus niger</i>	13	13
<i>Candida albicans</i>	13	14

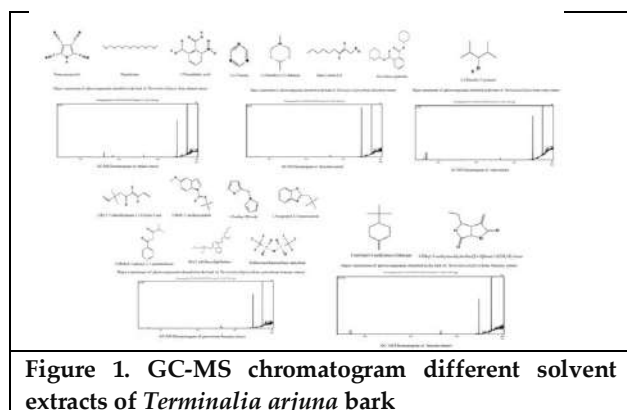
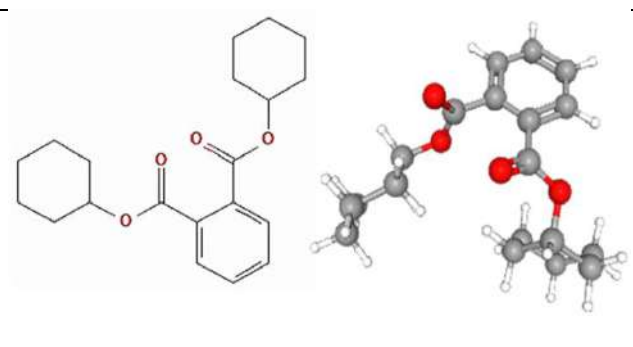
Figure 1. GC-MS chromatogram different solvent extracts of *Terminalia arjuna* bark

Figure 2. Molecular structure of Dicyclohexyl phthalate





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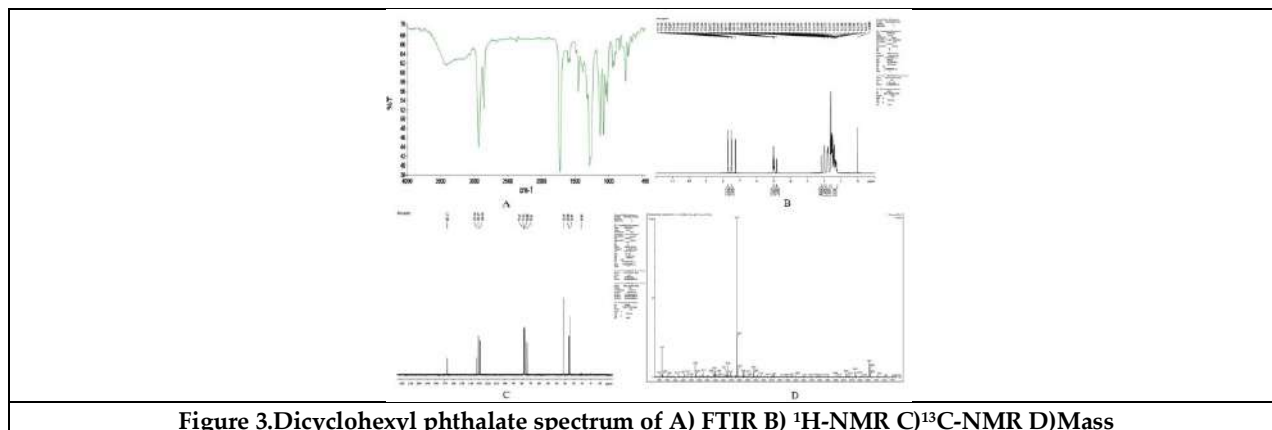


Figure 3.Dicyclohexyl phthalate spectrum of A) FTIR B) ^1H -NMR C) ^{13}C -NMR D)Mass





Validation of Analytical Method for Estimation of Dolutegravir Sodium in Synthetic Mixture using Hydrotropic Solvent

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ABSTRACT

A simple, precise, rapid, accurate photometric method was developed for the estimation of dolutegravir sodium in synthetic mixture. The initial stock of dolutegravir was prepared by using 2% mannitol as hydrotropic solvent. The standard solution of dolutegravir sodium in water shows a maximum absorbance at 257nm. The linearity was found between 6µg/ml and 40µg/ml with correlation coefficient (r^2) > 0.9976. The method was validated as per ICH guidelines. The assay of the synthetic mixture was found to be 101.12%. The recoveries were found to be 101.10, 99.78, and 98.21% for 80, 100 and 120% respectively. The developed method is economical and simple; hence it can be used for routine quality control test for dolutegravir in bulk and pharmaceutical formulation.

Keywords: Validation, dolutegravir, synthetic mixture, hydrotropic solvent

INTRODUCTION

Dolutegravir sodium (Figure 1) is the monosodium salt of dolutegravir. It is an antiviral medicine which is used for treatment of HIV-1. It is an orally bioavailable integrase strand-transfer inhibitor (INSTI), with activity against human immunodeficiency virus type 1 (HIV-1) infection. Dolutegravir binds to the active site of integrase, an HIV enzyme that catalyzes the transfer of viral genetic material into human chromosomes. This prevents integrase from binding to retroviral deoxyribonucleic acid (DNA), and blocks the strand transfer step, which is essential for the HIV replication cycle. This prevents HIV-1 replication. Hydrotrophy is a unique and unprecedented solubilization



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technique in which certain chemical compounds termed as hydrotropes can be used to affect a several fold increase in the aqueous solubility of sparingly soluble solutes under normal conditions. This increase in solubility in water is probably due to the formation of organized assemblies of hydrotrope molecules at critical concentrations.[1,2] Literature survey revealed a few methods reported for the estimation of dolutegravir in single and combined dosage form using various analytical methods like UV- visible spectrophotometer, HPLC and LC-MS [3-9]. Previous estimation method for dolutegravir using organic solvents like methanol[3,5] by using spectrometric analysis and HPLC method by acetonitrile[6] are toxic, costlier and sources of pollution. Inaccuracy in spectrophotometric estimations due to volatility of organic solvents is another drawback of these solvent. Therefore, it was thought worthwhile to make use of hydrotropic solubilization techniques in development of new spectrophotometric methods for the analysis of poorly water-soluble drug, dolutegravir.

MATERIALS AND METHODS

The drug sample of dolutegravir API was received as a gift sample from Dr. Reddy's laboratory. The analysis was performed on Shimadzu 1780 UV – Visible spectrophotometer. Other instruments used are electronic balance and ultra sonicator. All the chemicals used were of laboratory grade.

Selection of Solvent

Dolutegravir is a poorly water soluble drug. To check the better aqueous solubility, various hydrotropes were used like sodium bicarbonate, polyethylene glycol, urea and mannitol. Among these hydrotropes, dolutegravir was found to be more soluble in mannitol. Hence mannitol was selected as a diluent.

Preparation of Standard Stock Solution

10 mg of dolutegravir was accurately weighed and transferred into 10 ml volumetric flask. It was dissolved using 2% mannitol by ultra-sonication and the solution was made up to the volume. About 2.5 ml of above solution was further diluted to 25 ml with distilled water and the final concentration obtained was 100 µg/ml.

Selection of Maximum Wavelength

The standard solution was further diluted to 10 µg/ml using water and scanned between the wavelengths of 200 – 400 nm using water as blank.

Validation

After the method development, the same should be validated. ICH guidelines were followed for the validation of the developed method.[10]

Linearity and Construction of Calibration Curve

An aliquot of standard stock solution was further diluted with water and the solutions are attained at the concentration between 6 – 40 µg/ml. The absorbance was measured at 257 nm. All concentration stocks are prepared as triplicate and three measurements were obtained from all the stocks.

Specificity

Specificity is the ability to assess the presence of analyte equally in the components that may expected to present. The specificity was determined by comparing the spectrum of synthetic mixture solution with that of standard solution. The sample was checked for any interferences from the excipients.

Precision

The precision of analytical procedure expresses closeness of agreement (degree of scatter) between a series of measurement obtained from multiple sampling of same homogenous sample under the prescribed conditions. Precision was determined in terms of repeatability, inter day precision and intraday precision



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Repeatability: Repeatability is measured by analysing six samples of same concentration of the drug (10 µg/ml). The spectra was recorded and absorbance was noted

Intraday and Inter day Precision: Intraday precision was carried out by analyzing the drug at five concentrations (6, 10, 20 µg/ml) and each concentration for three times, on the same day. Inter day precision was carried out similarly but analysis is carried out for different days.[10-12]

Robustness

The robustness of the method is capacity to remain unchanged by minor changes in condition. The experimental conditions were changed to find the robustness and assay was evaluated. The effect of detection of wavelength was studied at ± 2 nm

Preparation and Assay of Synthetic Mixture

The synthetic mixture was prepared by mixing the weighed quantity of Dolutegravir sodium (API), Micro crystalline cellulose, Magnesium stearate and Mannitol in a mortar intimately.

Powder equivalent to 10 mg of dolutegravir was weighed and transferred into 10 ml volumetric flask and it is dissolved and made up with 2% mannitol. Around 2.5 ml of above solution was then made up to 25 ml with distilled water (100 µg/mL). From this solution an aliquot of 2 ml was diluted to 10 ml and the concentration made was 20 µg/ml. The absorbance was measured at 257 nm. The procedure was repeated 6 times for concentration of 20 µg/ml.[12]

Recovery

To ensure accuracy of the method, recovery studies were performed using the standard at 80, 100, 120% level for already analyzed sample (10 µg/ml) and subsequent sample was re analyzed. At each level, three determinants were performed. Accuracy is reported as percentage recovery, the expression for calculation is

% Recovery = (Observed value \times 100) / True value

RESULTS AND DISCUSSION

Selection of Wavelength for Analysis

Spectral analysis of the prepared dolutegravir solution shows maximum absorbance at 257 nm (Figure 2). It was selected for analysis of the sample and standard.

Linearity (Calibration Curve)

The calibration curve was constructed by plotting the absorbance against corresponding concentration (Figure 3). The overlying spectrum was given in Figure 4. The drug obeys to Beer Lambert's law and show linearity from 6 – 40 µg/ml with correlation coefficient (r^2) 0.9976.

Repeatability

From the stock solution the concentration of 20 µg/ml was prepared for six times and the absorbance was found. The % RSD was calculated for the absorbance of six samples and it was found to be 0.64% which is lesser than 2% according to ICH guidelines (Table 1, Figure 5)

Intermediate Precision

From the stock solution triplicate of 6, 10, and 20 µg/ml concentrations were prepared and the absorbance was obtained. The mean of triplicate was found and the %RSD was calculated which falls under 2% according to ICH guidelines. The procedure is repeated for next day for inter day precision (Table 2, Figure 6).



**Robustness**

Robustness of the developed method was tested by changing the wavelength of detection by ± 2 nm and the method was found to be robust (Table 3).

Assay of Dolutegravir in Synthetic Mixture

The amount of dolutegravir present in the synthetic mixture was estimated by comparing the absorbance of sample with standard absorbance. The assay of the drug was in good agreement with the label claim. The test obtained are shown in the table 4

Recovery

The recovery was obtained by keeping the concentration of sample (10 μ g/ml) same but varying the concentration of standard for 80, 100, and 120% (Table 5).

CONCLUSION

Use of hydrotropic solvent for the estimation of dolutegravir by a simple, reliable, straight forward UV spectrophotometric method was developed and successfully validated. The results of validated test shows that the developed method was precise, robust, and accurate. The developed method was suitable for routine analysis of pharmaceutical formulation in quality control and it also economical.

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Table 1 Precision Results

Concentration applied (20 µg/ml)	Absorbance found (µg/ml)	% RSD
Sample 1	0.480	
Sample 2	0.484	
Sample 3	0.478	0.64%
Sample 4	0.485	
Sample 5	0.478	
Sample 6	0.479	

Table 2 Intraday and Inter Day Precision

Concentration (µg/ml)	Intra Day precision	% RSD	Inter Day precision	% RSD
	Absorbance Found*		Absorbance Found *	
6	0.131	0.94	0.130	0.62
10	0.235	0.88	0.236	0.61
20	0.479	0.20	0.485	0.34

*mean of three determinants

Table 3 Robustness

Wavelength	Assay	% RSD
255	100.26	1.71
259	102.05	0.87

Table 4 Results of Assay

Concentration in µg	Absorbance	Label Claim (mg)	Amount found (mg)	% RSD
20	0.485	50	50.00	0.96
	0.490		50.51	
	0.497		51.23	
	0.486		50.10	





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	0.490		50.51	
	0.495		51.03	
		Mean	50.56	

Table 5 Recovery Studies

Level of addition	Amount of drug added ($\mu\text{g/ml}$)	Amount recovered *SD ($\mu\text{g/ml}$)	% Recovery	% RSD
80%	16	16.176 \pm 0.050	101.10	0.39
100%	20	19.957 \pm 0.141	99.78	0.87
120%	24	23.571 \pm 0.150	98.21	0.68

*mean of three determinants

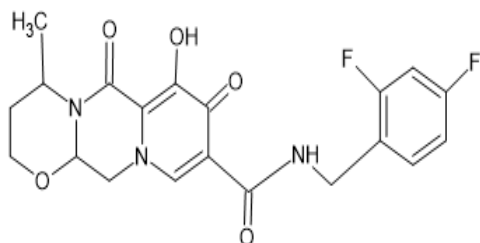


Figure 1 Structure of Dolutegravir

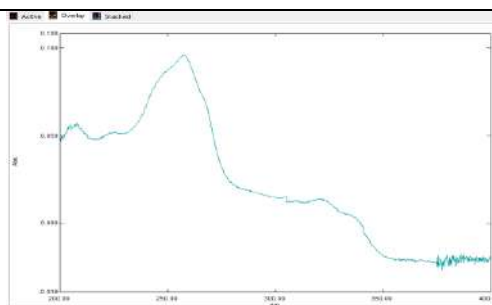


Figure 2 UV spectrum of Dolutegravir sodium

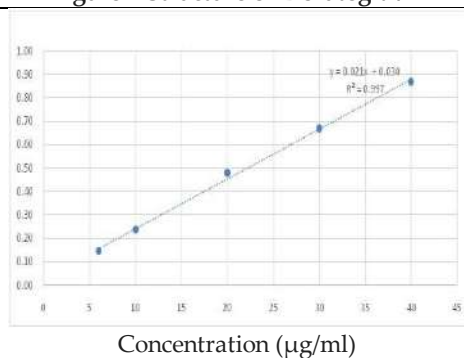


Figure 3. Calibration curve for dolutegravir sodium standard

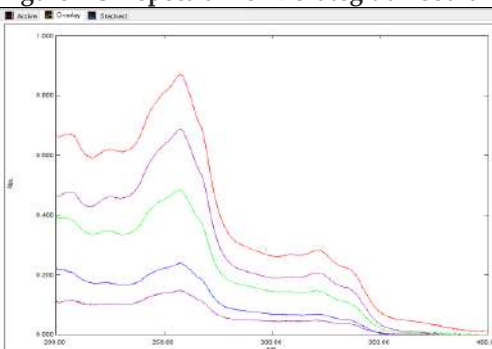


Figure 4 Overlay spectrum of dolutegravir sodium standard

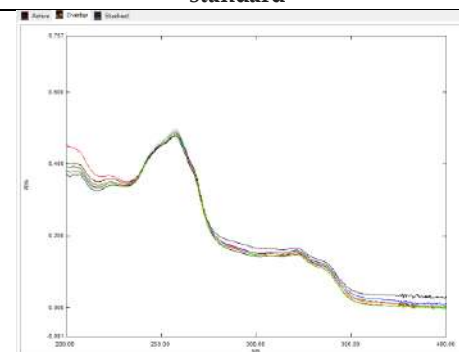


Figure 5 UV spectra for method precision

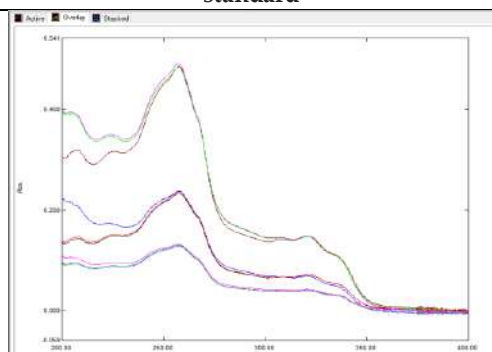


Figure 6 Spectra showing Intraday and inter day precision





RESEARCH ARTICLE

A Statistically Validated Electrochemical Study of Some Metal Ligand Complex with the Evaluation of Its Physicochemical and Potential Biological Properties

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ABSTRACT

In order to determine the ligand-metal ratio of the complex in solution, the current electrochemical study evaluates a complexation process involving a single metal, ferrous, and a single ligand, EDTA, as well as its physicochemical features. The ligand metal ratio in the complex has been determined using the "Monovariation method" in order to determine the complexing nature of this complex. Using the Modified Job's approach (Turner Anderson approach) for conductance measurement and potential (mV) calculation, the stability constant of the generated complex was determined. Potentiometric and conductometric principles were used in the study, and the temperature as well as the ionic concentration of the metal and ligand solution may have an impact on the experiment's ultimate result. An extension of the above mentioned method can be used for the patients with beta-thalassemia need ongoing blood transfusions. Additionally, following a blood transfusion, iron (in ferrous form and conjugate with other macromolecules) accumulates in their bodies; chelation therapy can lessen the issue.

Keywords: Potentiometry; Conductometry; Monovariation method; Modified Job's method; Chelation; Metal ion.



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INTRODUCTION

Complexometric Titration

When the Multidentate Ligand forms a complex with a metal ion, it takes the form of a ring structure and is commonly referred to as a chelate. The term "chelating agent" refers to the ligands that create chelates. One effective chelating agent is EDTA.

Electrochemistry

The area of chemistry studies where the chemical alterations brought about by electricity as well as the chemical alterations necessary to produce electricity. Electrical charge is transferred between electrodes and electrolytes during these reactions. Both conductometric and potentiometric titration are included.

Validation Parameter

The parameters under consideration in the present study is precision with its accepted %RSD values[1].

Stability Constant

The kind of equilibrium constant employed for the production of metal complexes in the solution is called a stability, formation, or binding constant. The intensity of interactions between ligands and metal ions involved in complex formation in the solution can be measured acutely using the stability constant [2]. Any metal complex with a larger stability constant will be more stable overall. The term "instability constant" has been adopted to refer to the different values of the stability constant that occur at 1/k times. [3].

Thermodynamic stability

A state of chemical equilibrium occurs when the concentrations of reactants and products remain constant across the course of the reaction. This scenario frequently arises when the forward and reverse reactions happen at the same speeds. It is noteworthy that at this point, the forward and backward response velocities are equal rather than zero. The thermodynamic method yields important information about the development of metal chelates. A particularly helpful method for differentiating between enthalpic and entropic effects is thermodynamics. The enthalpic effect has a complete influence on the bond strengths, and it has no bearing on the overall order or disorder of the solution. The greatest explanation for the chelate effect below comes from thermodynamics. The change of standard Gibbs free energy for equilibrium constant is response:

Free energy change: $\Delta G = -2.303 RT \log K$

R = gas constant

T = absolute temperature

Log K = Stability Constant For metal complexes

There are two ways to interpret the stability constant in the solution: kinetic stability and thermodynamic stability. According to the preceding equation, a reaction is defined as a change in energy when it proceeds from reactants to products. However, kinetic stability—which relates to ligand species—is what drives this system's reactivity. [4].

Factors affecting the stability constant of metal complexes

Equilibrium concentration of the free metal ion

Temperature

Analytical concentration of the metal ion

pH of the solution.





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MATERIAL AND METHODS

Chemicals

All the chemicals used were of Analytical Grade. Ferrous Chloride (Lobachem, India, 0.1 M, 0.05M), Ferrous Ammonium Sulphate (Lobachem, India, 0.1 M, 0.05M), Ferric Chloride (Lobachem, India, 0.1 M, 0.05M) and EDTA (Merck, India, 0.1M, 0.05M) were prepared by using double distilled water in 100 volumetric flask for several times and has been used in subsequent times for different method.

Monovariation method (Mole ratio method/Yoe-Jones method)

Yoe and Jones [5] introduced this technique. A range of solutions with varying ligand concentrations under comparable conditions and a constant metal concentration overall are created. The relationship between the potential (mV) and conductance value and the number of ligand to metal moles was plotted. With the aid of the molar metal: ligand complexation process, the end point was represented as the occurrence of constant potential value for potentiometric titration. The point at which the conductance value abruptly changes during the titration will be the end point for the conductometric process.

Potentiometric/Conductometric titrations for detection of Metal-Ligand ratio (Monovariant method) [6]

Metal solution and ligand solution of 0.1M strength was prepared with distilled water. Metal salt solution was taken in a beaker and this was titrated potentiometrically/conductometrically against 0.1M ligand (EDTA) solution that was taken in a burette.

Modified Job's method (Method of Continuous Variations)

The modification of the Job's [7] continuous variation method performed by Vesburgh and Cooper [8] was applied to find the stoichiometric and formation constant of the complex. The case of co-ordination may be described by:



A series of solutions are prepared in which the sum of total concentration of M and L is kept constant but their proportions are continuously varied. The potential (mV)/conductance values of the series is plotted against the mole fraction of the ligand. The ratio of the stoichiometric coefficients is determined from the mole fraction at the point of constant potential value obtained in the curve for atleast two consecutive time. First constant value corresponding to the mole metal: ligand ratio will be the endpoint of the titration. In the case of conductometric titration the abrupt change in the conductance values will be the marker of the end point. Three series of solutions, C1, C2, and C3, were created by preparing equimolar solutions of ligand and metal solutions. The metal salt solution in set C1 was filled to a total volume of 12 ml in each, ranging in volume from 0 ml to 12 ml. Comparably, ligand solution was filled in C2 and C3 was made by combining ligand solution from 12 ml to 0 ml with metal salt solution from 0 ml to 12 ml. For every solution, the conductance value and potential (mV) values were noted. The formula for Δ mV/conductance was "C1+C2-C3" [9]. Plots of the potential (mV)/conductance values and the mole metal-ligand ratio were made. The graph's equivalency point can be used to calculate the composition and stability constant [10, 11].

Turner Anderson Method for determination of stability constant

Turner and Anderson [12] have modified Job's method and have successfully used for determination of stability constant. By plotting a continuous variation curve for a given range of compositions and then repeating the procedure for more dilute solutions. If the initial concentrations of the metallic ions and ligands are 'a' and 'b' respectively, then

$$K = \frac{X}{(a-x)(b-x)}$$

Where, K = Stability Constant
x = Concentration of the complex





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If any two solution were taken of different concentration where a_1 , a_2 and b_1 , b_2 represent the concentrations of the metal and the ligand respectively on the two curves, then:

$$x = \frac{a_2b_2 - a_1b_1}{(a_2 - a_1) + (b_2 - b_1)}$$

Where, the subscripts 1 and 2 refer to the reagent concentrations. Thus “K” be calculated by solving the equation after having the value of x .

For the present study the stability Constant equation according to Turner Anderson Method is-

$$x = \frac{a_2b_2 - a_1b_1}{(a_2 - a_1) + (b_2 - b_1)} \dots\dots\dots (1)$$

$$k = \frac{x}{(a-x)(b-x)} \dots\dots\dots (2)$$

k = stability constant, $(a-x)$ and $(b-x)$ are the concentration of (product-reactant) in case of ligand and metal if calculated from Modified Job's Method.

x = concentration of complex

a , b = initial concentration of metal and ligand (0.1M).

a_1 , b_1 = concentration of metal and complex for 0.1M metal and ligand solution.

a_2 , b_2 = concentration of metal and complex for 0.05M metal and ligand solution.

After evaluating the value of x from equation no. 2, it can be substituted in equation no. 1 to find out the stability constant value.

Method Precision

Here In the method precision titration has been carried out for 6 times for a single cation with EDTA for two different electrochemical methods separately. This indicates whether a method is giving consistent results when analysed for six times with the calculation of % RSD by employing monovariation method.

Acceptance criteria: % RSD should be in between 98%-102%.

RESULT AND DISCUSSION

Potentiometric method

Ferrous Chloride and EDTA

Monovariation method

$V_{S1} = V_{S2}$

V_{S1} = Volume and Strength of EDTA

V_{S2} = Volume and strength of Ferrous Chloride

$33 \times S_1 = 50 \times 0.1$

$S_1 = 50 \times 0.1 / 30 = 0.167 \text{ M}$

So approx., Metal: Ligand Ratio = .1: .167

Modified Job's Method

The end point was found out at 5:7 of Metal: Ligand ratio.

Turner Anderson Method

End point were observed at 7:5, for 0.1M and for 0.05M also.

Calculation of Stability Constant

In this case

$k = 15.6213$

So $\log k = 1.193717$

Calculation of Free energy Change

Free energy change: $\Delta G = -2.303 RT \log K = -6240.14 \text{ Kcal/mole}$



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t= titration

This process is precised methodically as %RSD value comes within 2%.

Conductometric Method

Ferrous Ammonium Sulphate and EDTA

Monovariation method

VIS1= V2S2

V1S1= Volume and Strength of EDTA

V2S2= Volume and strength of Ferric Ammonium Sulphate

36XS1=50X0.1

S1= 50X0.1/30= 0.138 M

So approx., Metal: Ligand Ratio = .1:138

Modified Job's Method

The end point was found out at 5:7 of Metal: Ligand ratio.

Turner Anderson Method

End point were observed at 7:5, for 0.1M and for 0.05M also.

In this case

k= 19.08639

So logk= 1.280724

Calculation of Free energy Change

Free energy change: $\Delta G = -2.303 RT \log K = -6694.96 \text{ Kcal/mole}$ **Method Precision**

t= titration

This process is precised methodically as %RSD value comes within 2%.

Spectroscopic estimation of Ferrous- 1, 10-Phenanthroline complex (λ_{max} - 509.6 nm

From the standard curve it was seen that-

Ferrous- EDTA complex having the concentration of 0.523129 ug/ml where absorbance of that solution was 0.582

CONCLUSION

This research shows that, when utilizing 0.1M metal and ligand solution for the experiment (Monovariant approach), the complex formation of ferric and ferrous salt with EDTA occurred about at a 1:1 ratio. The complex's stability constant and the free energy change were determined using the modified Job's method of continuous variation, often known as the Turner Anderson Method. The fact that the free energy change value is negative indicates that complex creation is feasible. 1, 10- Phenanthroline was used as the chromogenic agent which essentially confirmed the presence of free metal content in the solution as EDTA was used as ligand in the assay process of metal- chromogenic agent complex. The spectroscopic data shows the concentration from the standard curve that where free metal was exist in the titration solution. In future this method can also be used to find out the stoichiometric ratio of other metal and different ligands along with the evaluation of different biological activities like in the treatment of Beta-Thalassemia when conjugation with ferrous ion takes place.

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Table 1: Monovariation Method

Volume of Titrant	Potential (mv) value
0	228
1	230
2	262
3	220
4	222
5	226
6	228
7	232
8	233
9	234
10	233
11	237
12	236
13	238
14	239
15	239
16	240
17	240
18	241
19	242
20	242
21	243
22	243





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36	245
37	245
38	245
39	245
40	245
41	245
42	245
43	245
44	245
45	245
46	245
47	245
48	245
49	246
50	246

Table 2: Modified Job's Method

	C1(M:S)	C2(S:L)	C3(M:L)	(C1+C2)-C3
RATIO	M:S	S:L	M:L	
00:12	-46	194	189	-41
01:11	12	190	192	10
02:10	23	192	191	24
03:09	25	191	191	25
04:08	25	189	192	22
05:07	30	188	190	28
06:06	29	189	190	28





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07:05	29	195	187	37
08:04	31	183	183	31
09:03	32	179	177	34
10:02	33	44	175	-98
11:01	34	35	40	29
12:00	36	55	75	16

M= Metal, S= Solvent, L= Ligand

Table 3: Turner Anderson Method (0.1M)

	Potential (mv)			0.1M
Ratio	M:S(C1)	S:L(C2)	M:L(C3)	C1+C2-C3
00:12	-12	227	227	-12
01:11	-12	226	228	-14
02:10	-10	223	229	-16
03:09	-9	221	229	-17
04:08	-8	220	230	-18
05:07	-6	217	231	-20
06:06	-4	211	232	-25
07:05	-5	206	231	-30
08:04	-4	204	230	-30
09:03	-2	198	229	-33
10:02	-2	187	224	-39
11:01	-1	181	221	-41
12:00	-2	42	14	26

M= Metal, S= Solvent, L= Ligand

Table 4: Turner Anderson Method (0.05M)

	Potential (mv)			0.05M
Ratio	M:S(C1)	S:L(C2)	M:L(C3)	C1+C2-C3
00:12	-34	180	107	39
01:11	-22	178	-25	181
02:10	4	46	-139	189
03:09	-26	45	-25	44
04:08	-14	45	-169	200
05:07	-24	42	-180	198
06:06	-23	43	-181	201
07:05	-22	40	-182	200
08:04	-15	40	-175	200





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09:03	-19	38	-176	195
10:02	-15	34	-179	198
11:01	-16	23	-178	185
12:00	-17	15	-18	16

M= Metal, S= Solvent, L= Ligand

Table 5: Method Precision

			Potential (mv)						
Volume of titrant added	t1	t2	t3	t4	t5	t6	Mean	S.D	% R.S.D
1ml	231	230	231	231	230	231	230.6667	0.516398	0.223872
2ml	105	100	102	101	101	100	101.5	1.870829	1.843181
3ml	102	101	100	98	103	102	101	1.788854	1.771143
4ml	210	211	211	211	211	210	210.6667	0.516398	0.245126
5ml	215	214	214	214	214	214	214.1667	0.408248	0.190622
6ml	219	218	218	218	218	217	218	0.632456	0.290117
7ml	222	223	222	221	219	218	220.8333	1.94079	0.878848
8ml	225	226	225	224	221	221	223.6667	2.160247	0.965833
9ml	227	228	227	226	223	223	225.6667	2.160247	0.957273
10ml	229	230	233	232	226	225	229.1667	3.188521	1.391355
11ml	231	232	232	232	227	226	230	2.75681	1.198613
12ml	233	233	234	234	229	227	231.6667	2.94392	1.270757
13ml	234	234	233	233	229	229	232	2.366432	1.020014
14ml	235	236	236	237	230	230	234	3.162278	1.351401
15ml	236	238	238	239	231	230	235.3333	3.88158	1.649397
16ml	241	238	239	240	241	241	240	1.264911	0.527046
17ml	238	239	239	240	232	232	236.6667	3.669696	1.550576
18ml	238	240	240	241	233	233	237.5	3.619392	1.523955
19ml	239	241	242	242	234	234	238.6667	3.777124	1.582594
20ml	240	242	241	242	235	235	239.1667	3.311596	1.384639

Table 6: Monovariation Method

Volume of titrant added	Conductance
0	16.7
2	16.9
3	17.7
4	18
5	18.5
6	18.7
7	18.9





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8	19.4
9	19.5
10	19.6
11	19.9
12	20.5
13	20.8
14	21.2
15	21.4
16	21.9
17	22.1
18	22.5
19	22.6
20	23.1
21	23.2
22	23.6
23	23.9
24	24
25	24.2
26	24.3
27	24.6
28	25
29	25.1
30	25.7
31	25.9
32	26
33	26.1
34	26.4
35	26.8
36	26.9
37	25.4
38	24.6
39	24
40	23.6
41	23.1
42	22.4
43	22
44	21.5
45	20.9
46	20.3



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47	20.2
48	19.9
49	19.4
50	19.1

Table 7: Modified Job's Method

	C1	C2	C3	C1+C2-C3
Ratio	M:S	S:L	M:L	Conductance
00:12	0.344	13.3	13	0.644
01:11	2.79	12.3	13.7	1.39
02:10	5.09	11.9	14.3	2.69
03:09	7.26	11.4	15.1	3.56
04:08	12.33	10	17.2	5.13
05:07	13.86	9.94	18	5.8
06:06	17.7	9.38	23.3	3.78
07:05	18.5	9.74	25.1	3.14
08:04	18.8	9.86	26.4	2.26
09:03	24	4.68	24.2	4.48
10:02	25.1	3.43	20.4	8.13
11:01	25.4	1.98	18.7	8.68
12:00	27.1	65.3	17.4	75

M= Metal, S= Solvent, L= Ligand

Table 8: Turner Anderson Method (0.1M)

Ratio	M:S(C1)	S:L(C2)	M:L(C3)	C1+C2-C3
00:12	0.92	13.3	14.3	-0.08
01:11	2.93	13.7	13.9	2.73
02:10	4.54	12.4	14.7	2.24
03:09	6.36	11.1	15.1	2.36
04:08	7.57	10.3	15.2	2.67
05:07	9.35	7.2	18.8	-2.25
06:06	10.1	8.17	22.8	-4.53
07:05	11.2	6.8	27.3	-9.3
08:04	11.5	5.92	22.5	-5.08
09:03	13.7	4.63	22.9	-4.57
10:02	14.8	3.42	20.9	-2.68
11:01	15.9	2.14	19	-0.96
12:00	16.9	0.97	17.4	0.47

M= Metal, S= Solvent, L= Ligand



Anindya Bagchi *et al.*,**Table 9: Turner Anderson Method (0.05M)**

Ratio	M:S	S:L	M:L	C1+C2-C3
00:12	0.23	7.69	7.69	0.23
01:11	1.79	7.01	7.84	0.96
02:10	2.53	6.74	8.11	1.16
03:09	4.31	6.38	8.69	2
04:08	4.64	6.03	9.54	1.13
05:07	5.48	5.28	10.4	0.36
06:06	6.17	4.73	13.2	-2.3
07:05	6.84	4.07	16.6	-5.69
08:04	7.15	3.37	15.3	-4.78
09:03	8.12	2.66	13.7	-2.92
10:02	8.33	2.08	10.5	-0.09
11:01	9.24	1.2	10.5	-0.06
12:00	10.1	0.47	9.98	0.59

M= Metal, S= Solvent, L= Ligand

Table 10: Method Precision

Volume of titrant added (ml)	Conductance reading								
	T1	T2	T3	T4	T5	T6	Mean	SD	%RSD
1	15.6	15.8	15.7	15.1	15.6	15.3	15.51667	0.263944	1.701038
2	15.6	15.9	15.8	15.4	15.6	15.8	15.68333	0.183485	1.169935
3	15.9	16.3	15.9	16	15.8	15.9	15.96667	0.175119	1.096779
4	16	16.5	16.3	16.1	16.3	16.1	16.21667	0.183485	1.131458
5	16.3	16.7	16.6	16.2	16.7	16.7	16.53333	0.225093	1.361447
6	16.6	17	16.9	16.8	17.2	16.8	16.88333	0.204124	1.209028
7	16.9	17.3	17.1	17	17.6	17	17.15	0.258844	1.509292
8	17.2	17.5	17.3	17.3	17.6	17.4	17.38333	0.147196	0.846765
9	17.3	17.9	17.9	17.5	17.8	17.9	17.71667	0.256255	1.446407
10	17.9	18.3	18.2	17.9	18	18	18.05	0.164317	0.910342
11	18	18.5	18.5	18.3	18.3	18.3	18.31667	0.183485	1.001737
12	18.3	19	18.9	18.6	18.6	18.6	18.66667	0.250333	1.34107
13	18.8	19.2	19.1	19	18.8	18.3	18.86667	0.320416	1.69832
14	19	19.3	19.4	19.2	19	19.1	19.16667	0.163299	0.851996
15	19.3	19.5	19.8	19.5	19.4	19.6	19.51667	0.17224	0.882528
16	19.5	19.9	20	19.8	19.7	19.7	19.76667	0.175119	0.885931
17	19.9	20.2	20.1	20.1	20.2	20	20.08333	0.116905	0.582097
18	20	20.5	20.4	20.5	20.9	20.2	20.41667	0.30605	1.499021
19	20.1	20.7	20.5	20.9	21.3	20.6	20.68333	0.402078	1.943971
20	20.3	20.9	20.8	21.1	21.5	20.9	20.91667	0.392003	1.87412

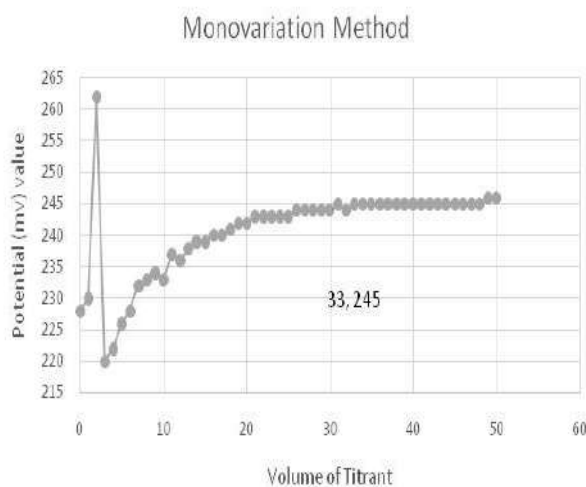


**Table 11: Spectroscopic data of Ferrous-1, 10-Phenanthroline complex**

Conc. (ug/ml)	absorbance
0.025	0.0126
0.05	0.0114
0.1	0.0073
0.5	0.1982
1	0.4043
1.5	0.6143
2	0.7198
2.5	0.9175

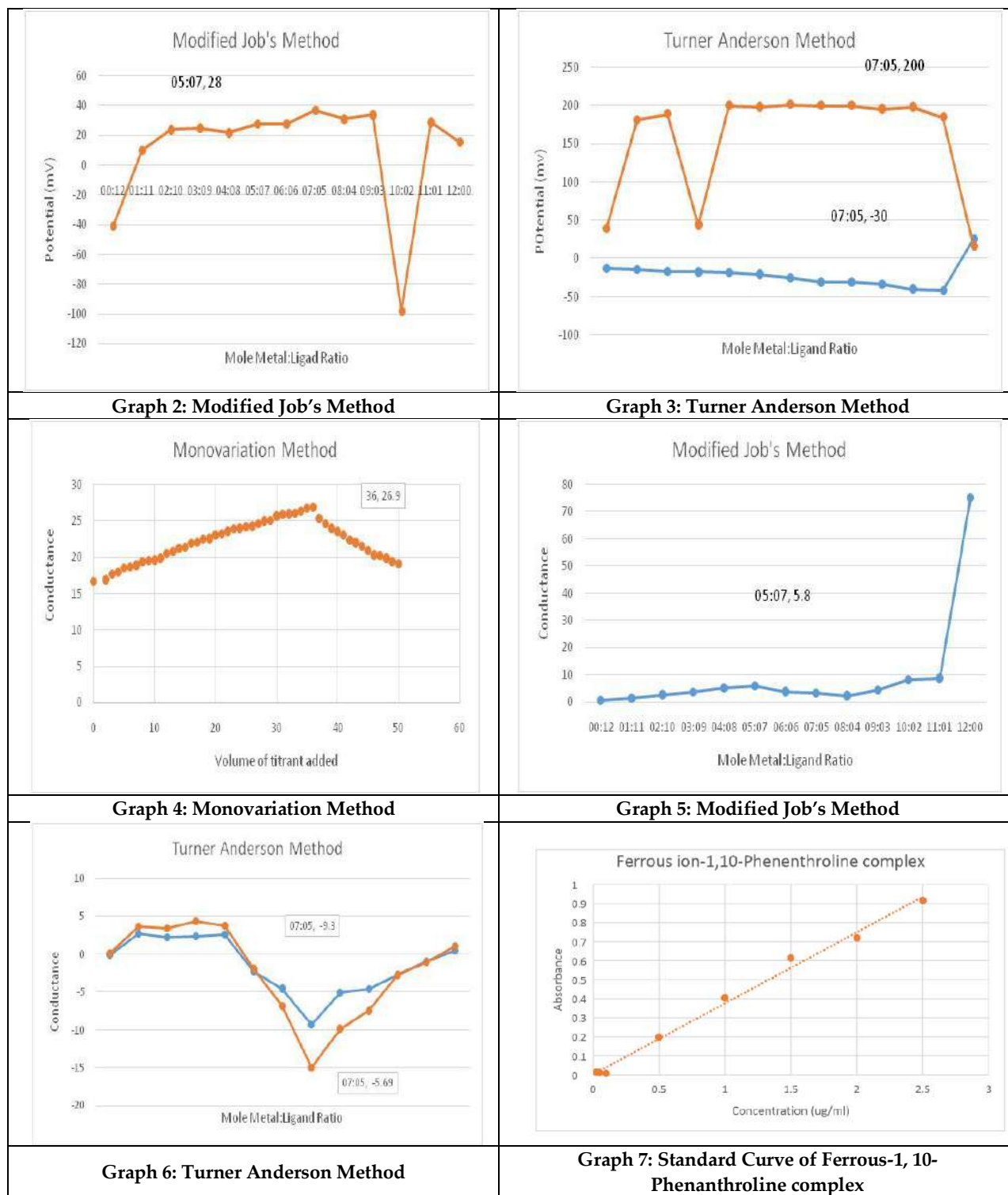
Table 12: Summary of the observed results

Electrochemical method	Metal-ligand complexation method	Expected value	Observed value	Reason for deviation
Potentiometric Ferrous- ligand complex	Monovariation method	1:1	1:1.167	Temperature/Ionic concentration of metal or ligand.
	Modified Job's method	1:1	5:7	
	Turner Anderson method	1:1	7:5	
Conductometric Ferrous- ligand complex	Monovariation method	1:1	1:1.138	Temperature/Ionic concentration of metal or ligand.
	Modified Job's method	1:1	5:7	
	Turner Anderson method	1:1	7:5	

**Fig 1: Structure of EDTA Complex****Graph 1: Monovariation Method**



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Treatment of Oily Wastewater from Textile Yarn Industry : A Critical Review

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ABSTRACT

The textile industry is widely recognized as an extremely expensive and complex industrial network within the manufacturing field. The manufacturing of a textile requires numerous mechanical processing phases, such as spinning, knitting, weaving, and the manufacture of garments. Although these stages appear to be independent of the wet treatment processes, which include sizing, desizing, scouring, bleaching, mercerizing, dyeing, printing, and also finishing operations, a strong interrelation exists across dry processes along with consecutive wet treatments. At each and every stage of fiber and fabrics processing, and the creation of garments, the textile industry releases a wide array of harmful pollutants into the environment. This investigation aims to offer a review of the oily wastewater treatments in the textile yarn industry as well as focuses on various techniques, notably highly effective technology for yarn textile oily wastewater, with a specific emphasis on an in-depth evaluation of the various treatment modalities. In this study, relevant procedures for treating textile wastewater, such as UV/H₂O₂, photocatalytic degradation employing nanophotocatalysts, TiO₂/UV/H₂O₂, acoustic cavitation, ultra filtration, and Nanofiltration, as well as their mechanisms, are discussed. The outcomes of the research indicate that the most effective procedures are those involving oxidation, as well as physical and biological processes.

Keywords: Oily Wastewater; Textile Yarn Industry; Physical; Biological; Supercritical; Oxidation



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INTRODUCTION

The term "Textile" was initially utilized to refer to woven fabrics along with the actions that made up the procedure of weaving. Also, it is a type of flexible woven substance that is created by a network of threads or yarns that are composed of natural and synthetic fibers (Adane et al., 2021). The word "fabric" encompasses any substance produced via the interlacement of fibres, whereas the term "textile" encompasses any material suitable for use in the manufacturing of various commodities, and may be created using techniques such as weaving, knitting, crocheting, and so on. Recently, the production of textiles has been completely revolutionized by the introduction of new technologies that include chemical, biological, and physiochemical means. Nevertheless, the escalation of extensive industrialization along with the acceleration of human population expansion has resulted in a perilous magnitude of wastewater that poses significant threats to both human well-being and the environment. (Awan et al., 2022). There is not much of a difference between conventional and contemporary procedures when it comes to the most prevalent types of woven fabrics, like plain weaving, along with twill weaving, or even satin weaving.

In addition, the depletion of natural water sources has resulted in a variety of negative effects, such as droughts, arise in the populace, and a rise in water amount required by companies, notably those involved in the production of textiles (Bhatia et al., 2017). Due to the fact that water is required for the sustenance of all forms of life along with meeting ever-increasing industrial demand, it is imperative that water be conserved. It is possible to promote this conservation in textile yarn industries by the utilization of a number of different measures, including water recycling and reuse as a result of oily wastewater treatment. According to Ahmed et al. (2021), the curing and reuse of textile wastewater that contains oil, are realistic options for conserving and enhancing already existing water resources as well as decreasing the discharge of harmful contamination into the environment. The methods described previously, which we have evaluated in this investigation, might be employed in numerous textile wastewater curing along with reuse practices. This curiosity in cleaner technologies is developing (Rajabinejad et al.(2019); Dey & Islam (2015); Allafi et al. (2022). In addition to this, it has the ability to supply researchers with fresh ideas, which may in the future lead to the development of new methods that are more effective. However, additional research may be necessary for both these methods and the treatment that was described in order to gain a comprehensive understanding of each mechanism. In addition, every subsequent strategy needs to have a great amount of detail described regarding it. In this manner, the new researcher will have a better chance of understanding and developing their theory as well as new ways in the subject of oily water treatments in the textile yarn sector.

CRITICAL ANALYSIS OF TRADITIONAL OILY WASTEWATER CLEANING METHODS

The conventional techniques for cleansing oily wastewater are proving to be inefficient. For illustration, the DAF (Dissolved Air Flotation) cleaning method can only marginally separate oil droplets being ≤ 20 microns from wastewater. This is a significant limitation. Before the flotation process can begin, the wastewater needs to be pre-treated by additional units (Hu et al., 2019). This is necessary so that the droplets can be even smaller. This will inevitably result in a greater physical footprint as well as increased financial investments. In the meantime, the flocculation and demulsification processes that are used to clean oily wastewater can lead to activated sludge creation. This is an issue because it happens to be toxic when dumped into a watercourse that is open (Abuhasel et al., 2020). The electrochemical technique has a drawback in that the material of the electrodes can corrode (Zhang et al., 2020). The limits of each of these traditional approaches are outlined in the below figure 1. In nutshell, the following factors warrant the necessity of the creation of novel or combined technological solutions:

- In order to improve treatment efficacy while simultaneously lowering the system's operational and maintenance expenses, which are caused by issues like sedimentation, corrosion, fouling and excessive energy usage.
- Complex nature of oily industrial effluents typically comprising of oil, hazardous compounds, refractory organics, inorganic salts, extracellular polymeric substance (EPS), and biological pollutants.



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- The conception of a technique that happens to be less harmful to the environment through the prevention of secondary contamination, the use of compounds that are not biodegradable, and the accumulation of sludge (Srimoke et al., 2022).
- When compared to standalone systems, integrated systems have demonstrated a higher level of long-term operational stability (Zhang et al., 2022).
- Make it possible to employ the recovered oil, along with water, even sludge for purposes like energy production, water purification, and fertilizer production, correspondingly, without harming living beings or the environment.

CURRENT TECHNOLOGIES FOR TREATING OILY EFFLUENTS FROM TEXTILE YARN INDUSTRY

As reported by Per Samaei et al. (2018), the textile industry is known for producing oily wastewater that is ubiquitous for posing a major challenge to the regular oily wastewater curing practice due to its relatively low biodegradability index. It is necessary to purify the water before allowing it to mix with the natural water supply since the water may contain particles that are both suspended and dissolved. In addition, numerous different techniques were created to accomplish effective wastewater treatment that is also economical. Methods of oxidation, physical methods, biological methods, and physicochemical techniques were among the several treatment strategies, each of which might then be further subdivided into a variety of methods. In the following sections, this study will discuss a variety of techniques that are recently reported as being highly relevant and applicable in the curing of oily wastewater straight from the textile yarn industry.

Oxidation processes

These are the methods that are utilized the vast majority of the time in order to break down dyes and other compounds that are found in wastewater. The oxidation processes described below can be carried out alone or in concert with one another, depending on the circumstances (Holkar et al., 2016). There are a few different approaches to oxidation, each of which will be broken down and examined individually in the following section.

UV/H₂O₂

It takes around twenty minutes for this procedure to completely eliminate the color, and it can eliminate 63% of the overall organic carbon in 90 minutes (Hynes et al., 2020).

Photocatalytic Degradation Using Nano Photocatalysts

Complete mineralization of the dyes may be attributed to the company's developing technology, which is the factor that is accountable for the latter. According to Jamil et al.(2020), the process of photolysis, when combined with nanophotocatalysts, has the ability to partially decompose between 50 and 80% of micro pollutants such as dyes (Asghar et al., 2015).

Combinations of TiO₂/UV/H₂O₂

The subsequent UV, UV-H₂O₂, UV-TiO₂, and (UV-TiO₂-H₂O₂) cycles resulted in decolorization efficiencies of 18%, 27%, 37%, and 64%, respectively. There are lighting periods that last 100 minutes each (Salem et al., 2019).

Hydrogen peroxide in subcritical water

There was a correlation between the temperature of the experiment and the pace at which H₂O₂ was converted into hydroxyl radicals. The most effective RR120 degradation was achieved with 0.5% w/vH₂O₂ across all dye concentrations along with temperature tested at 200°C along with 1% hydrogen peroxide by weight(most intense conditions) (Bilińska&Gmurek, 2021).





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Acoustic cavitation

As per the dye used and the cavitation type that was performed, the level of degradation in the acoustic environment along with hydrodynamic cavitation was 50-60%. Uniting hydrodynamic cavitation along with chemical oxidation results in the most effective decolorization of dye effluent (Hassaan & El Nemr, 2017).

Hydrodynamic cavitation with H_2O_2 , CCl_4 , along with Fenton's reagent

Cavitation in combination with H_2O_2 along with cavitation in combination with Fenton chemistry are both used in the decolorization of Rhodamine to 99.9%. Approximately 82% of the original quality has been lost due to the interaction of cavitation and CCl_4 (GilPavas et al., 2018).

Hydrodynamic Cavitation(HC)

An acidic medium is utilized in the process of Oil & Grease (OG) being converted into HC. The slit venturi was shown to have a nearly 50% higher degradation rate along with cavitation yield in comparison with the other two cavitating devices that were tested, despite the fact that the amount of energy given was the same (Torres et al., 2019).

Biological Treatment (BT)

The only textile wastewater components that are altered by the biological progression are the components that have been dissolved. The efficiency of the elimination process can be affected by numerous factors, like organic load: dye load ratio, microorganisms' load, temperature of the system, and the amount of oxygen present in the system (Hossain et al., 2022). On the basis of whether or not they require oxygen, biological activities can be divided into one of the three categories: aerobic, anaerobic, anoxic or even facultative, along with any combination of the two. The anaerobic process is utilized in the curing of textile wastewater having a high COD, whereas the aerobic process is utilized in textile wastewater's curing with a relatively low COD content. According to Mzahma et al. (2017), in actual practice, an amalgamation of aerobic and anaerobic methods is typically utilized. The treatment of wastewater may make use of a variety of biological processes, some of which are listed here.

Fungal cultures for dye degradation

A fungal culture has the ability to modify its metabolic rate in reaction to environmental changes in which it is grown. This skill is absolutely required to ensure their continuous existence. The metabolic activity that takes place here is influenced by enzymes from both inside and outside the cell. These enzymes have the ability to degrade a wide variety of dyes that are found in the wastewater produced by the textile industry.

Algae for degradation dyes

The bonds creating the dye's chemical structure are broken by the enzymes, which make it possible for the dye to be transformed into other chemical compounds whereas, the process of biosorption involves the movement of color from the liquid phase to the solid phase. Current research suggests that certain species of the green macroalgae genus *Cladophora* are able to degrade azo dyes (Simoni & Glaar, 2023). This ability is attributed to the presence of the enzyme azoreductase in these organisms.

Microbial fuel cell

Microorganisms with electrochemically active electron transport chains in the anode chamber of a microbial fuel cell system cause the oxidation of various organic chemicals found in textile effluent. The aforementioned procedure facilitates the production of protons and electrons, afterward transported to the cathode compartment, where the conversion of oxygen into water takes place. (Hasan et al., 2022). According to Parrino et al. (2019), the elimination percentages attributed to biological treatment, membrane filtering, and photocatalytic reaction are 40%, 30%, and 25%, respectively. Parrino et al. (2019) conducted a study whereby they showcased the effectiveness of a sequential treatment system comprising of a membrane bioreactor (MBR) and a photocatalytic reactor (PCR), as seen in the figure 2 below. The results of their study revealed that this system achieved a remarkable 95% elimination of total organic content (TOC) from slop wastewater. The figure below shows the sequential treatment system.



**Patel Hiteshkumar Laljibhai and Priya Saxena****Supercritical Water Technology (SCW)**

This method serves as a viable substitute to incineration. Supercritical water oxidation (SCWO) along with supercritical water gasification (SCWG) is utilized in the treatment of heavy oil-concentrated wastewater, such as oily sludge (Li and wang, 2020). In the SCWO method, water is used above its thermodynamic critical point (374°C and 22.1 MPa) as the reaction medium. This enables the H–C–N molecule to be converted into H₂O, N₂ molecular, and carbon dioxide through an accelerated oxidation process in a very short amount of time (van Wyk et al., 2020). After being neutralized with a base, byproducts including chlorine, phosphorus, and sulfur are converted into the mineral acid or salt that corresponds to their original form (Austin et al., 2023). The liquid and gaseous products do not require any posttreatment before being released into the environment. Operating conditions and performance evaluation pertaining to SCWO and SCWG employed in various research works are depicted in Table 2.

Physical methods

The elimination of color from wastewater that contains dispersion dyes and other compounds can also be performed through the use of physical processes. These techniques have a restricted application since they have low decolorization efficiency and, as a result, generate a significant amount of sludge (Verma et al., 2021). Peat, bentonite clay, fly ash and polymeric resins are samples of cheap adsorbent substances that were utilized by particular investigators in order to make the adsorption method economically viable. However, the use of these adsorbents are restricted due to the presence of numerous issues. For this reason, adsorbents should only be employed in processes that produce modest concentrations of pollutants, or when the adsorbent in question is either very inexpensive or easily regenerable. The sections that follow provide an explanation of some of the several physical processes that can be utilized to treat water.

- In the process of ultra filtration, water is pushed through a membrane that is only partially permeable to it in order to remove impurities.
- Nanofiltration is an innovative technology for the treatment of wastewater that offers a number of benefits, including minimal energy consumption and straightforward operation.
- The loose nanofiltration (LNF) membrane is an emerging technology that has shown promising results. Investigators propose LNF membranes possess significant promise for the use of resveratrol-based LNF membranes in the cleanup of saline textile effluent. The LNF membrane is a novel technological advancement that has shown very favorable results. Researchers have postulated that these membranes possess significant potential for many applications.
- In the innovative process known as sol-gel-assisted interfacial polymerization, the synthesis of titanium dioxide is combined with an interfacial polymerization reaction at the same time. This strategy allows for the efficiency along with morphology of the LNF membranes to be tuned, as well as the endowing of membranes with the ability to clean themselves (Samsami, et al., 2021).
- Ions' mass transfer through RO membranes in the process of reverse osmosis is regulated by diffusion; therefore, one way to think of it is as a diffusion-controlled process (Feng et al., 2021).

Microelectrolysis

Microelectrolysis is a technique that is used to treat wastewater that has a high concentration of oil and also contains a considerable proportion of organic polymers, salt, and chemical cleaning agents. Some examples of this type of wastewater are acid mine drainage, storm water, and effluent from the pre-plating process. In micro electrolysis, multiple chemical processes are combined into a single operation, including oxidation–reduction, electrochemistry, physical adsorption, flocculation, and others. This one method might be used to accomplish a number of other treatment procedures, including discolouration, better flocculation, refractory organic oxidation, and an increase in biodegradability (Huong et al., 2021).

Membrane Separation Technology (MST)

Due to its capacity to extract the majority of chemicals as well as inorganic and organic compounds from wastewater, membrane separation technology (MST) has been the topic of intensive investigation over the last decade for the



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curing of oily wastewater. When compared to other conventional approaches, MST only necessitates a smaller land mass, and as a result, it has a lower carbon footprint. Utilizing MST as a means to accomplish efficient, selective, and reliable pollution separation is a possibility. In addition, MST has excellent productivity, stability, a low defect rate, and is cost-effective to utilize. It is important to highlight the fact that the treated water's quality is, for the most part, unaffected by the differences in the influent. In addition to this, it has potential applications in the recycling of particular waste streams for a variety of diverse purposes. At the moment, much research is being conducted on polymer and ceramic membranes to filter oily wastewater (Yalcinkaya et al., 2020).

Physiochemical Methods

The development of efficient cost-effective solutions for curing wastewater discharges from the textile sector should currently be the principal focus of efforts to reduce water pollution. This is necessary in order to protect aquatic life in water bodies. According to Torres et al. (2019), the physiochemical processes of ion exchange, adsorption, irradiation, and oxidation are the most prevalent ways used to treat textile wastewater. These processes also produce valuable results. The methods of coagulation along with flocculation are successful for the elimination of color from dispersion and sulfur dyes, but their capacity is restricted for chemical and vat dyes. The use of the aforementioned procedures is also restricted because of their poor treatment performance and considerable creation of sludge. Because of their superior elimination effectiveness, which is based on high affinity, the ability to target compounds, and a preference for adsorbent regeneration, adsorption techniques have garnered a significant amount of interest in recent years (Hossain et al., 2022). According to this study, textile businesses are responsible for environmental damage due to the discharge of wastewater, the formation of solid waste, along with air pollutants, and also noise pollution (Zazou et al., 2019). However, these industries also provide things, goods, and products. In the textile business, water is utilized for washing raw materials and performing a variety of flushing treatments at various stages of the production process. According to Halepoto et al. (2022), the manufacture involves both chemical and physical procedures, such as sizing, de-sizing, scouring, bleaching, mercerizing, dyeing, finishing, and printing.

The wastewater that is released from the textile industry contains dangerous elements such as colors, chromium, sodium hydroxide, starch, acid, and so on. The World Bank reported that the dyeing along with finishing department is responsible for approximately 17%–20% of the overall industrial effluent. This percentage can be attributed to the wastewater that is produced by the department (Yin et al., 2019). It is estimated that treatment facilities around the world receive approximately 300,000 t of synthetic dyes on a yearly basis (Yang et al., 2022). In addition, the polluted water could contain hazardous contaminants that have an effect not only on the quality of the clean water but in aquatic plants' photosynthesis (Shaheen et al., 2022). Hence, the allocation and management of water pose a substantial challenge in the context of textile manufacturing operations. This is primarily due to the need for access to electricity along with agriculture, both of which prioritise environmental stewardship. Key considerations in this regard include addressing CO₂ emissions, disclosing carbon information, promoting the use of renewable energy, and enacting energy conservation measures. These efforts are crucial for attaining sustainable development objectives (Mostafa, (2015); Mondal et al. (2017); and Azanaw et al., (2022). It is possible to stop water pollution's flow into our native watersheds if these challenges are addressed with environmentally friendly treatment solutions. (Lin, L. et al 2020). This would protect the health of the general population as well as the ecosystems that are located in our immediate environment.

CONCLUSION

In spite of the use of all available technologies, the technique for treating oily wastewater is static energy-rigorous, unstable, it requires major expenses for operation and installation, and doesn't generate the promised output. In summary, research has shown that Membrane bioreactor (MBR) treatment is the most efficient oil recovery process. In order to treat oily wastewater in a way that is both effective and economical for the textile yarn industry, it is necessary to make use of more modern techniques, nanotechnology, and to integrate all of the relevant components. In this part of the article, the future course of action for each oily wastewater treatment system is examined in detail





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and highlighted. The next phase in the progression of this research will concentrate on the primary obstacle that must be overcome in order to create a biological treatment system. This obstacle must be overcome in order to maintain the system's stability while it is exposed to high toxicity and salinity in the wastewater stream.

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Table 1: Lists of Biological Treatment' (BT) effectiveness as documented in the literature.

AUTHORS AND YEARS	TREATMENT SYSTEM	POLLUTANTS MONITORED	REMOVAL EFFICIENCY (%)
Jimenez-Espadafor et	Activated Sludge Reactor (AGR)	Oil	90.31





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al. (2011)			
Ghosh & Chakraborty (2019)	Activated Sludge Reactor (AGR)	Oil COD NH ₄ ⁺ -N	67.40 99.95 92.65
Morgan-Sagastume et al. (2019)	Anoxic–oxic MBR	O & G COD	96.5 97.14
Kadivarian et al. (2020)	Single chamber Microbial Fuel Cell arrangement in Parallel and Series	COD	PFC-42.4 SFC-88.9
Muzzammil & Loh (2020)	Anaerobic Moving Bed Biofilm Reactor (AnMBBR)	COD	67
Bakar et al. (2020)	Use two mesophilic modular reactor for Aerobic and Anaerobic plant	COD TSS BOD	98.90 91.60 99.58
Ghosh & Chakraborty (2020)	Moving bed biofilm reactor (MBBR)	NH ₃ -N COD	94.42 59.44

Table 2: Studies report indicates that operational outcomes affect SCWO and SCWG

AUTHORS AND YEARS	TREATMENT SYSTEM	PERFORMANCE EVALUATION
Kou et al., (2018)	Continuous SCWG	Optimum value of carbon and Hydrogen gasification efficacy (CE) attained at 680°C; H ₂ =54.34% CH ₄ =16.50 CE=97.34% CO ₂ = 25.15% The addition of alkaline catalyst improves the yield of H ₂ and CE, CO ₂ and CH ₄ from 16.07, 39.50 and 73.93 from 21.37 mol/kg diesel, 36.27 and 26.27 mol/kg, respectively Also, Reduce COD from 7.95 g/L to 0.86 g/L
Kipcak&Akgun (2018)	SCWG in a batch reactor system	High CE content=98.81% at 600°C H ₂ generation improvement by Catalyst (21.1 to 63.3 mol/kg) and decrease production of CH ₄ Reaction of methenation control by ZrO ₂
Mainil& Matsumura (2019)	Anoxic–oxic MBR	97 % TOC removal was obtained



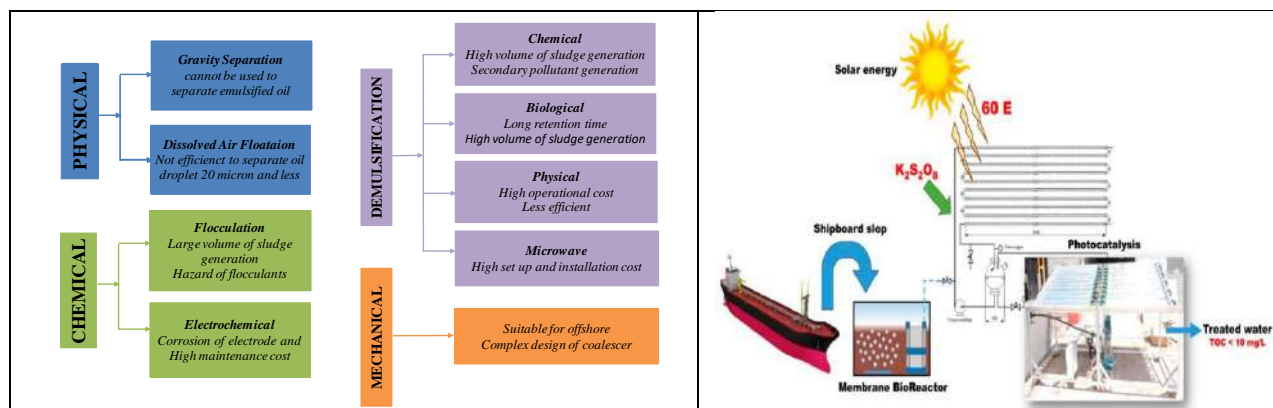


Figure 1: Limitations of traditional approaches for cleansing oily wastewater (Abuhasel, et al., 2021)

Figure 2: Combined MBR and PCR for the treatment of slop water from ship. (Parrino et al., 2019)

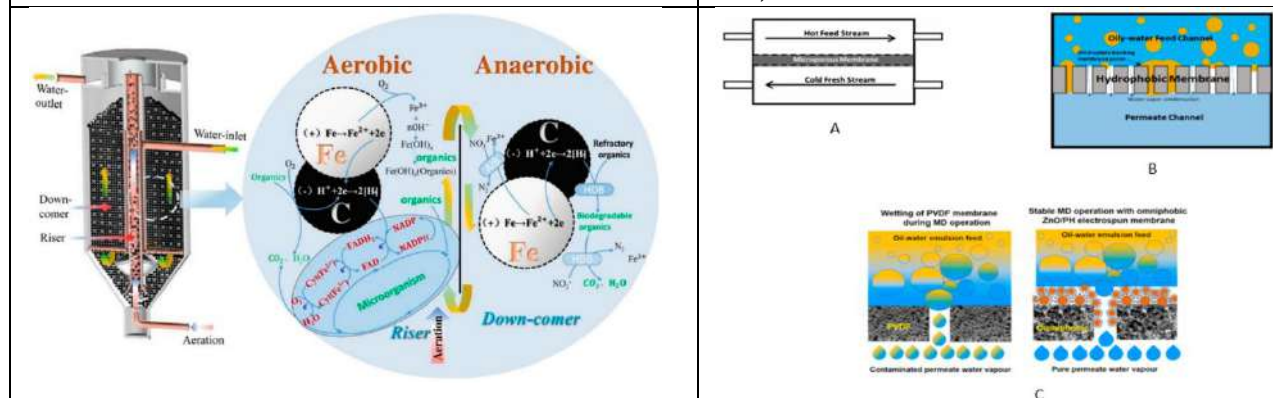


Figure 3: Combined of Membrane bioreactor and MES (Abuhasel et al., 2021)

Figure 4: Flow diagram of the upstream direct contact membrane distillation process (Abuhasel et al., 2021)





O-SE-R: An OCR Tool for UML Class Diagrams

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ABSTRACT

Sketching is an integral part of the Agile methodology. In the early phases of software development, various UML diagrams are sketched on paper to better understand the requirements and various perspectives of software development. These sketches, though very rapid and easy to modify, are often not documented and difficult to understand at later phases of development. This paper introduces a novel optical character recognition(OCR) tool for UML Class Diagrams. The proposed tool can generate a code skeleton from a free-hand drawing of a UML class diagram for a system. The tool takes an image of a free-hand sketch of a UML class diagram. It then localizes the classes and inheritance symbols in the sketch. Next, using the endpoints of the line segments in the sketch, it identifies two types of relationships between classes: association (between two classes) and generalizations (between a base class and one or more concrete classes).

Keywords: Association, Contour Detection, Code Skeleton Generation, Inheritance, OCR Tool, UML Class Diagram, YOLOv3

INTRODUCTION

The agile methodology is central to software development in the industry today due to its emphasis on innovation and rapid development[1]. In the agile methodology, an initial vision is first translated into user stories. These user stories represent functionalities that are to be implemented. A subset of these user stories is implemented during a

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short period of time called a sprint. Each sprint lasts around two to three weeks on average[2] and is overseen by a scrum master. Since the agile methodology follows an iterative and incremental development strategy[3], the software artifacts are incrementally improved during each sprint. High-priority user stories are resolved first, followed by secondary stories. In this setting, agile practitioners find it very difficult to follow the formal software engineering process. The said process consists of six phases: requirement analysis, system design, implementation, testing, deployment, and maintenance[4]. Each phase has its own purpose and a unique set of artifacts. In order to save time, agile practitioners either completely skip the initial phases of software development or draft rough sketches of these artifacts for the sake of understanding the problem and the needs of the software. These rough sketches are often not documented and are very difficult to comprehend by other teams in the agile development process. The Unified Modeling Language (UML) is a general-purpose, developmental modeling language in the field of software engineering that is intended to provide a standard way to visualize the design of a system[5]. It is most often used for software engineering but has extended its use to business processes and other project workflows. UML is considered an extension of software engineering to object-oriented development. OO Development breaks down the problem into classes and objects[6]. The Unified Modeling Language has a set of thirteen diagrams to illustrate the software design from various perspectives. One such diagram is the class diagram, which describes the static structure of the system's classes, attributes, and the relationships between them[7]. Our proposed tool seeks to provide a means to document free-hand UML class diagrams in a concise manner for future use. Our tool can be able to integrate with the agile development process. Practitioners can continue to sketch UML class diagrams but now have the added advantage of documenting their work in a standard manner that can be understood by all.

LITERATURE SURVEY

Prior to the commencement of the work, a thorough literature survey was conducted to understand the current state of development of OCR tools in academia and industry. Though several approaches have been implemented in academia, the industry has not yet experimented with image processing for enhancing its solutions/services. Gosala et. al.[8] developed a novel Convolutional Neural Network (CNN) to perform binary classification of images as UML diagrams or non-UML diagrams. The dataset used by the authors consisted of a total of 3298 images of which 1649 images were UML diagrams and the other 1694 were non-UML diagrams. They proposed two CNN models, one without regularization and one with regularization. For the CNN without regularization, four convolutional layers and four pooling layers were used. Data augmentation was used to avoid overfitting. Two activation functions, ReLU and Sigmoid, were used. ReLU was used in the hidden layers and Sigmoid in the output layer. Adaptive momentum estimation (Adam) was used for optimization and Max-pooling is used in the pooling layer. For the CNN with regularization, five convolutional layers and five pooling layers were used. ReLU and Sigmoid activation functions were used. Adam Optimizer, Max-pooling, and L2 regularization with different weight functions were used for the evaluation. Hammond[9] developed a system that enhances UML free-hand class diagrams and creates a digital version. The system can recognize general classes, dependency associations, inheritance associations, and aggregation associations. The system uses stroke information to predict the various notations of the UML class diagram.

Classes

A general class can be drawn with one to four strokes; A collection of strokes is classifiable as a general class if most of the points fall between the bounding box of the strokes and a slightly smaller internal bounding box.

Associations

To recognize an arrow, the recognizer first attempts to locate the head and tail of the arrow by finding the points furthest from each other. The head is defined to be the stroke endpoint closest to the other line segments. The algorithm then locates the arrowhead's side points by finding the points furthest from the head-tail line and lying on either side of this line. The line segments are then examined to determine where they fall to determine the association





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type. This system, however, did have some shortcomings. It could recognize only the outlines of the UML class diagram. The author hasn't provided information on the efficacy of her approach. The system can't recognize the text within the class diagram shapes. Finally, the system only uses a fixed stroke behavior for understanding the UML class diagram. Hammond[10] also introduced an optimized version of the system described in [9]. The system is now able to recognize aggregations and dependency associations. The process for identifying these associations is as follows:

1. Locate the arrow shaft by locating the two points furthest from each other (points A and B).
2. Locate the arrowhead ends by locating points furthest from the arrow shaft on either side (points C and D).
3. Let point E be the point on line AB that is twice the distance from B as the intersection point of lines CD and AB.
4. Classify each of the line segments as part of the arrow shaft, an arrowhead section, or unclassified (AB, BC, BD, CD, CE, DE, or unclassified) based on the line's bounding box, slope, and y-intercept.
5. Based on the results of the line-segment classification, classify the arrow type as dependency, inheritance, aggregation, or leave the strokes unclassified.

However, since the system is based on the same stroke-based principles of [9], it doesn't generalize very well. In the industry, commercial applications can generate a code skeleton if the user develops software artifacts using those tools. Rational Rose can generate a code skeleton from a UML Class Diagram provided that the diagram is designed using the software[11]. Other similar tools like UModel, Visual Paradigm, and Enterprise Architect[12,13,14] can convert UML diagrams drawn using their tools to code. However, the major drawback of these tools is that it is very time-consuming to draw UML diagrams using these tools.

Design of the Tool

Our proposed solution, O-SE-R, can generate a concise representation of a UML class diagram. Initially, it takes an image of a free-hand UML class diagram as input and performs a binary threshold on it. Next, it uses the YOLO object detection and localization model to get the bounding boxes of the classes and inheritance symbols. These classes are then numbered sequentially from left to right and top to bottom. The tool removes the extracted bounding boxes to obtain a new image with only line segments for classifying the inheritance symbols. Later these line segments are clustered into disjoint subgroups using contours. This grouping of line segments helps associate the endpoint of each line segment to the nearest class. Then for each line group, the endpoints of the line segments are found. This is done by checking the neighborhood of the point. If the neighborhood of the point has only black pixels, then it indicates that the point is an endpoint. On the other hand, if it has at least one white pixel in its neighborhood, then it is not an endpoint. At last for each endpoint, the nearest class or inheritance symbol(whichever is nearest) is found. This is done by using the Euclidean distance metric. Finally, each line group is classified as follows:

1. If the line has more than two endpoints and at least one endpoint associated with an inheritance symbol, then it is an 'inheritance' line segment.
2. If the line has only two end points, then it is an 'association' line segment.
3. In any other case, classify it as an error.

The algorithm is shown below:

Algorithm

convert UML Sketch To Code(image, height_of_image, width_of_image)

Inputs

1. image - An RGB image
2. height_of_image: Height of the RGB image
3. width_of_image: Width of the RGB image

Output

code Skeleton - returns a code skeleton of the UML class diagram



Priyadharsini *et al.*,

1. Pass the input image to YOLO_SE1 and obtain the bounding boxes.
2. Pass the resulting bounding boxes to the NMS thresholding algorithm to remove overlapping boxes.
3. Obtain a new image, *img_1*, by masking the bounding boxes from the original image. Store the center points of those boxes.
4. Group the lines in *img_1* using contours.
5. Find the endpoints of each line group.
6. For each endpoint in the line segment group, find the nearest class.
7. Classify the line group as follows:
 - i. If the line has more than two endpoints and at least one endpoint associated with an inheritance symbol, then it is an 'inheritance' line segment.
 - ii. If the line has only two endpoints, then it is an 'association' line segment.
 - iii. In any other case, classify it as an error.
8. Initialize the codeSkeleton.
9. For each class in the UML class diagram:
 - i. Initialize class base code.
 - ii. Add all the classes inherited by it.
 - iii. Add all the associations as attributes.

Return codeSkeleton

The tool returns a nested array to represent the UML diagram concisely. Each subarray has two or more elements. A subarray with two elements represents an association. The two class names will be mentioned in the subarray.

Dataset

A dataset of free-hand UML class diagrams was used to train the object localization model and to test the performance of the tool[15]. The dataset was split into two folder folders, one having 140 images and the other having 70 images. On top of this dataset, we annotated the UML classes and inheritance symbols for training the object localization model. One image, from the folder with 70 images, was corrupted and subsequently removed.

YOLO for object localization

In order to detect and localize the UML classes and inheritance symbols, transfer learning was applied to a pretrained YOLOv3 model. YOLOv3 was used due to its decent localization accuracy and fast inference time in comparison to the other YOLO models. It was trained on 140 images of the dataset.

Evaluation

To evaluate the performance of the tool, we use 70 images from the dataset. In particular, the following tests were performed:

1. Number of Classes correctly localized
2. Number of Inheritance symbols correctly localized
3. Number of associations correctly identified.
4. Number of generalizations correctly identified.

The metrics are reported below:

Metric	Actual	Identified	Percentage
Classes	274	233	85.03%
Inheritance symbols	50	44	88.00%
Associations	144	64	44.44%
Generalizations	50	18	36.00%





Priyadharsini et al.,

Sample Images

Image	Code Skeleton
<pre> classDiagram class Citizen class Foreigner class Person Citizen --|> Person Foreigner --|> Person </pre>	<pre> [[('class', 1), ('class', 2), ('class', 0)]] </pre>
<pre> classDiagram class SecuritySystem { location: string } class Monitor { location: int mode: int } class Alarm { on: Boolean } class Controller { active: Boolean } SecuritySystem "1" -- "*" Monitor : monitors SecuritySystem "1" -- "*" Alarm : alarms SecuritySystem "1" -- "*" Controller : active </pre>	<pre> [[('class', 2), ('class', 0)], [('class', 3), ('class', 1)], [('class', 1), ('class', 0)], [('class', 3), ('class', 2)]] </pre>
<pre> classDiagram class MaintenanceAgency { } class Tenant { } class House { } class RealEstateAgency { } class Landlord { } MaintenanceAgency "0..1" -- "*" House : maintain Tenant "0..1" -- "*" House : lease House "*" -- "*" RealEstateAgency House "*" -- "*" Landlord </pre>	<pre> [[('class', 3), ('class', 2)], [('class', 3), ('class', 1)], [('class', 1), ('class', 0)]] </pre>

Test Set Results:

Total Number of Classes: 274
 Number of Classes Identified: 233
 % of Classes Identified: 85.03%

Total Number of Inheritance Symbols: 50
 Number of Inheritance Symbols Identified: 44
 % of Classes Identified: 88.00%

Total Number of Associations: 144
 Number of Associations Identified: 64
 % of Associations Identified: 44.44%

Total Number of Generalizations: 50
 Number of Generalizations Identified: 18
 % of Generalizations Identified: 36%





CONCLUSION AND FUTURE SCOPE

In this paper, a novel tool to concisely represent UML class diagrams has been developed. The model reduces the UML class diagram to a simple nested array. As shown in the examples, the tool is capable of recognizing classes and inheritance symbols from various kinds of images. Though the object localization model works very well, in the future some more research could be put into the contour detection algorithm to make it more robust.

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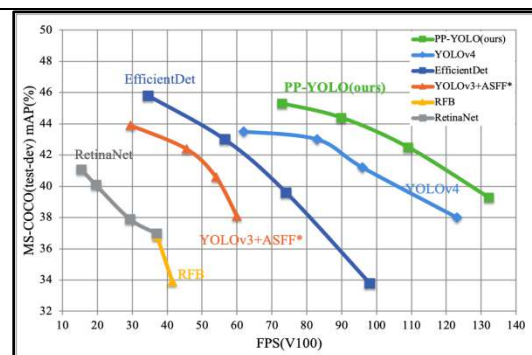


Fig. 1: Comparison of the YOLO family of models

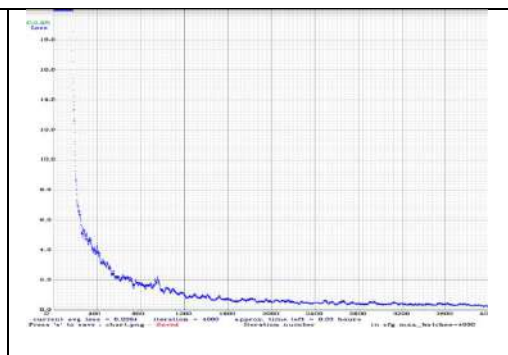


Fig. 2: YOLO Loss graph





RESEARCH ARTICLE

Upsurging Health Resilience System in India and European Countries: A Sociomedical Perspective

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ABSTRACT

The globe in the year 2020 was diffused with the outlandish and peculiar proliferation of Covid-19 disease, which within no time tagged itself 'pandemic'. The unforeseen event evoked mayhem across the global populace. This was especially discerned in the healthcare domain, owing to its bounded facilities and human resources, therefore summoning the need for a stronger and resilient health care system that can withstand itself, irrespective of the urgency. Literature suggests that the pivotal issue that challenged the countries from overcoming the pandemic was the availability of financial and medical assets, including proficient health professionals. However, very scarce light has been thrown into the impact on and of community dwellers on the efficacy of health care resilience system. Societal union on remedying survival threats may prove benign in securing wellness of individuals and reducing laboriousness in the health care system. The objective of the paper is to synthesize the interventions introduced during the pandemic in India and European countries, two of the many regions that were stirred by the pandemic breakout, and its pitfalls and consequences on their healthcare system. This study attempts to assimilate theoretical and practical wisdom of Seligman's 3P model of resilience, namely personalization, perseverance and permanence in understanding the role of community in battling a crises or pandemic in the future and how it may help promote the efficiency of the healthcare domain, through augmentation of psychological capital (Hope, Efficacy, Resilience and Optimism) of both global residents and health professionals.

Keywords: healthcare resilience system, pandemic, India, European countries, psychological capital, 3P resilience model





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INTRODUCTION

Health professionals form the foundational force behind any quality healthcare system. The consistent functioning of the healthcare system remains all time crucial towards serving the global society. Dearth of medical devices and services may create a bump in the road towards quality physical and mental wellbeing. One such example would be the elevation of mortality and morbidity rate (1) and a few other surging repercussions such as expatriation of populace and degradation of financial stability (2,3). Contagious explosion of deadly diseases wrought havoc on the global equilibrium (4,5). An exemplary of this would be the recent occurrence of the COVID-19 pandemic, that shook not just a few nations, but the globe as a whole. With original roots in China, it was soon declared a 'global pandemic' by the World Health Organization (WHO) on March 11, 2020 (6). The operation of the global community came to a halt at the onset of the pandemic (7). There was a downfall of medical facilities at the onset of the pandemic, that inevitably led to a much greater aftermath (8). Owing to higher prevalence of physical disorders, there was a demanding requisite for hospital beds in several parts of the world, including India, Tunisia, and Brazil (9). Exposure to disastrous natural or manmade events, namely hurricanes and earthquakes, or release of chemicals and nuclear attacks, respectively (10), though pose as threat to the healthcare system, may also offer an opportunity to reflect on and enhance its strength. The readiness of the healthcare system to build resilience against these mishaps relies completely on its capacity to meet the emerging needs of its consumers.

The higher the mindfulness on the part of healthcare sector, the greater would be its ability to tackle the challenges. Issues of non-resilient healthcare sector encompass reduced efficacy of disease outbreak management teams, lowered readiness to tackle epidemic problems, and ambiguous regulations and monitoring systems, among a few (11). As observed, earlier literature has portrayed the resilience of the healthcare system across the world. This paper, however, aims to synthesize the past studies that have examined the efficacy of healthcare system in India and European countries along with citing the pitfalls in the journey during the global pandemic as well as the plausible remediations for the same to strengthen the preparedness of the healthcare system for future pandemics, if come may. This may help the healthcare sector and policy drafters extract lessons for building effective strategies for the future. This study also aims to understand how community can collaborate with the healthcare sector to tackle pandemic and strengthen the preparedness of the healthcare system for future pandemics through the instrumentation of Seligman's 3P model of resilience and how this in fact results in cultivation of psychological capital 'HERO', i.e., Hope, Efficacy, Resilience and Optimism in the community and healthcare arena.

Reflection on the different phases of pandemic

Pre-pandemic

There has been an increasing incidence of epidemics and pandemics in the past few decades. The reconstruction of social and economic planes, which included change in climate, increased mobility in the international market and implementation of welfare policies, have each contributed to the birth of new epidemics and pandemics. The world in 2020, was ruled over by the fear of the new deadly threat that soon spread its wings across the globe, causing destruction, not limiting to physical health. The level of readiness the world healthcare domain carried around before the pandemic had an unignorable role in the way the world fought against the pandemic. Findings in a study conducted by Kapitsinis (2021) (7), implied that the privatisation of hospitals, lack of funds in the medical sector, and delayed containment and planning posed as a major threat to the under-efficiency of the healthcare sector, which in turn increased the death rate uncontrollably. However, there seemed to be a negative association between mortality and heightened costs incurred at the hospitals, quantity of health professionals available, and the number of people that were insured medically. Additionally, the hospitals that were comparatively largely funded and supported, reported relatively lesser rate of severity due to their close and consistent monitoring of patients (12,13). Another problem that had crippling effects was the remarkable deficit in drug supply in Australia, for instance, since US, its principal source, marked an increase of 37% shortage in their drug supply immediately prior to the pandemic (2019-2020) (14). This impacted not just the individual recipients of the drug but more broadly the healthcare system as well since it reflected its inefficiency.



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Similarly, Diktas et al. (2021) (15) in their study on occupational injuries found that exposure to blood and body fluids of the attended patients were relatively less in the period between pre-and during pandemic. Adequate training to healthcare workers could reduce the frequency of such exposures, as it may lead to severe occupational injuries otherwise. The adequacy of healthcare system in the pre-pandemic times were put to test at the onset of Covid-19, where it had to be stretched in several directions to gratify the rising needs of the population. The barriers faced before the pandemic were withdrawn as time demanded.

During the pandemic

Pandemic period was defined by its ambiguity, that affected every domain the world, particularly the health sector. Munawar & Choudhry (2021) (16) studied the psychological effect of covid-19 on the healthcare workers of Pakistan, as well as the methods of coping employed by them throughout. Findings suggest that media emerged as a primary source of panic and anxiety among the healthcare workers and the general population. Religious endeavours proved to be the only solace in midst of the wretched pandemic period. Meanwhile a study by Ardakani et al. (2022) (9) shows that student nurses have contributed to lower risks and flexible management of patients and available medical professionals, thereby building resilience. Allotment of backup hospitals to pandemic patients, there was an incurrence of only 37% of loss in humans, which was further downed to 5% post-establishment of field hospitals. A study by Yong-Shian Goh et al. (2020) (17) on nurses working in tertiary healthcare, with a minimum period of 1 year pre-pandemic, demonstrated that there were moments that challenged the physical and mental health of the participants in the first few months of Covid-19. There was perceived social support on the part of the nurses from their friends, family, and their workplace, which propelled them to stay determined to their professional responsibility and not get swayed with the free-floating worry that contained in their immediate environment. This shows that the participants showed immense resilience and carried their duties without disruption from the ongoing pandemic scenario. The response of the Government to the pandemic was through the implementation of non-medical and behavioural measures, including restrictions on the everyday social and financial living of individuals (13). It led to increased discomfort for the general population due to restricted direct access to various sources, personal and professional. Online transmission of communication between medical professionals and patients constrained the transfer of information and the reliability of the service due to the virtual distance between the attending parties. Several problems which remain unearthed for a relatively long time voiced out, due to the unforeseen challenges that lay beyond the capacity of the existing healthcare facility, calling for the need for advanced development.

Post-pandemic

As can be observed today, Covid-19 has never left its presence from the world. There is still a Corona virus epidemic at some sections of the world (18). Hence, it is important that the world, especially the healthcare domain stay prepared to face the future outbreaks of virus, to prevent dreadful consequences. Packiavathy and Gautham(2023) (19) proposes that a non-contact-based sanitizer that functions automatically be placed at public places as a gentle reminder to the general populace of the ongoing and ever-present covid-19 or its sister-viruses that may infect the world, yet again. This device not only acts as a shield against virus, but also tend to dispense data of the users and their susceptibility to diseases, to enable rapid quarantine. This proves beneficial for both community and the healthcare sector as they are kept self-aware of the plausible emergence of pandemic in the future, also preventing the potential spread of the virus to the neighbouring others. The need for equilibrium between personal and professional arena came to forefront post-pandemic. Prioritizing self-care among health care workers became pronounced through the development of relevant apps such My Wellness Coach (MWC) (20). There was rising evidence of improved technology in the healthcare domain to detain the scope for generation of future viruses. Being the hotspot for physical and mental health visitors, hospitals went and still undergo constant changes to match the rhythms of the times. In Iran, it was found that the way finding process among the visitors came to a standstill during and after the pandemic. There was utter confusion with the reorganization of spatial regulations after the social distancing norms were eliminated (21). Transition from pandemic to post-pandemic was not easy, as it had affected globally and in every domain of life, thereby restricting mobility of individuals. With increased presence of



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Covid-19 even today, it is a mandatory requirement for the healthcare system and policy makers take appropriate steps towards annulment of the efficacy of the virus in the future.

The ideal healthcare resilience system

A resilient health system can be seen as the potentiality of a health system to captivate variation in the environment, but simultaneously retaining its identity and operational capacity (22,23). It entails the ability of the healthcare domain to heighten its readiness to respond to unforeseen challenges, to sustain its core functionality even at the hit of crisis and being aware of the conditions that prevailed pre-during and post the crisis (24,25, 26).

Healthcare system builds its resilience through a set of changes (27, 28), as given below:

- a) **Preparedness:** At this stage, the healthcare system takes precautions to overcome any challenge that might show presence in the future. It takes necessary steps to understand the conditions that persist in the current medical environment, collect lessons from the past, and draft regulations for the future, in a way that bridges the gaps that might have barricaded scope for success in the past.
- b) **Shock onset and alert:** The healthcare domain identifies the arrival of the threat and comprehends its severity and root cause to determine its pre-destined effect on the population.
- c) **Shock impact and management:** The healthcare sector scrutinizes the impact caused or will cause on the general population and devise effective strategies to stay resilient in the face of adversity.
- d) **Recovery and learning:** Postcrisis, arrives the period of reflection of the performance and the pitfalls that might have occurred during the same. Taking note of the obstacles that came through during the time, will be helpful to stay aware and use better management techniques the next time as it occurs.

Navigating through these processes, enables the healthcare system build elasticity and pliability during turmoil. It is essential that the healthcare workers are trained to stay adamant and alert, to identify the arrival of a pandemic or epidemic and adopt effective strategies without a fore thought.

Health care resilience system in India and European countries

Covid-19 had casted its effect not in a particular part of the country, but rather the entire global community, simultaneously. This paper aimed to examine how pandemic had hit, India and European countries, specifically, and the barriers and successful experiences that would serve each other later in overcoming a similar situation in the future.

Instances of pandemic experiences in India

Thomas & Suresh (2023) (29) examined the factors that contributed to building sustainable resilience in healthcare sector in India. It was found that factors such as awareness of and preparedness for the environment, empowerment of team skills, efficient communication, capability to answer to needs of the people, and technological capacities may bolster the healthcare system. Vijayalakshmi et al. (2022) (30) assessed the role of resilience in the quality of Indian nursing student's life during the pandemic. The cross-sectional study demonstrated that the nursing students had normal level of resilience. There was an inverse relationship between effect of pandemic on resilient student nurses and their perceived knowledge of pandemic. Thus, it can be said that resilience holds a significant value in strengthening healthcare system. Gupta et al. (2023) (31) examined the existence of stress in the Indian healthcare sector. Results show that 52.6% of the sample demonstrated severity in psychiatric morbidity rate. Scarcity in availability of necessary medical facilities was found to be a significant stressor in Indian healthcare system. Roy et al. (2022) (32) studied the presence of stress and resilience among Indian post graduate trainees of tertiary care hospital and medical college in India. Highest level of stress was found among nurses in the Anaesthesia department and those in the radio diagnosis department showed the highest resilience. Resilience aid in better performance of medical professionals, thereby improving the quality of healthcare system. From the reviewed literature, it can be understood that the healthcare system's level of resilience, preparedness, and informativeness can help aid in future containment of pandemic.



**Vaishnavi Nambiar and Suyesha Singh****Instances of pandemic experiences in European countries**

Pandemic did not become prevalent in European countries until the Spring of 2021. The wave of Covid-19 hit European countries during the period of 2020-21, experiencing high risk of infections. Hungary reported the highest number of mortality rate, followed by Belgium, Finland, and France (33). Romani (2021) (34) compared and contrasted two resilient healthcare system of Italy during the pandemic. It was found that one of them seemed to exhibit more characteristics of resilience than the other, due to the availability of resources and transparent communication system that duly conveyed the risk factors of the pandemic to the general population, thereby blocking the severity of the disease. The situation improved with the help of governmental policies launched during pandemic. Federovo et al., (2023) (35) they were effective in reducing the frequency of the disease among the populace. This was especially evident in the countries positing higher degree of law. Feelings of sadness among population were found to lower the rapidness in spread of the pandemic in the European countries. The trust individuals placed in their higher governmental authorities proved to play a pivotal role in the effect of pandemic. Unim et al., (2022) (36) assessed the creative interventions used in European countries during the monitoring of pandemic in European countries. Few countries utilised virtual techniques to evaluate spread of the disease, while few other used the same for coverage of vaccine, research purposes, transparency of information, and prognosticate the influence of the disease among the population. While digital tools proved beneficial, it also threatened the online security and procurement of data. Technological innovations in the healthcare domain were fruitful in successful treatment of the disease. It can be observed in the studied literature, that interventions in European countries were more efficient due to the interference of technology, a driving force behind any innovation. However, it is to be noted that both countries had its own pitfalls and lessons that could be shared for the greater world to absorb and implement.

Barriers

There was a neglect of elder care nursing homes in Sweden caused by depreciation of medical competence of the health care facility (37). There was insufficient management of the health monitoring of individual patients, reduced conformity with the regulations of hygiene, thereby constraining the scope for limited spread of the virus (38). Nonetheless, there was increased upsurge in failure of the capacity of the medical assessment techniques and collaborative functioning of the healthcare system of the country. It took to charge only later when there was provision of national funds for improvement of the same. Shortage in hospital beds also rose as one of the major threats in the Netherlands. Beginning from the pre-covid scenario, it persisted during the pandemic, which limited the access of the needy to the healthcare system (39). This was a common challenge observed in India as well. There was a deficit in resources and infrastructure owing to low investment in the healthcare system, lesser trustworthy data, and insignificant leadership, all which ultimately impacted the health status of the patients (40). The process of decision-making took a toll on the healthcare professionals as there was a chaotic misconception of the severity of the pandemic. European countries had adopted a consolidated decision against fighting the pandemic (41), hence decelerating the implementation of the same. Nevertheless, states that functioned within their own decisional framework operated quicker due to lesser interventions from outside sources. Governmental programmes were launched in India to restrain the spread of pandemic, however, it posed as a challenge to implement the same in different small and large parts of the country, like Kerala, Karnataka, and Mumbai.

Unequal distribution of budgetary funds, reduced doctor-patient ratio (1: 1445) (41), and lowered physical and psychological support across states, seemed to be an obstacle in the path towards a virus-free community. This was reflected partly in some parts of European countries. Issues related to policies drafted during the pandemic were shown to have drastic effects (42). This was majorly due to the financial (43) and psychological taxing (44, 45) on people, lack of clarity in communication (46, 47), reduced efficiency of the governmental programmes, heightened coverage of vaccine and deterioration of trust (48, 49, 50) among people on the healthcare sector and the responsible higher authorities. Additionally, there was shortage of vaccines across European countries and India. In the first wave, the vaccination programmes were targeted on geriatric adults, which made it relatively easier for the pandemic to affect the younger age group of individuals. India had launched its first indigenous vaccine, Covaxin, which was soon accepted by the World Health Organization in 2021. However, the mass population was initially



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sceptical of the efficacy of the vaccine, due to the existence of various other foreign vaccines, the most efficient being Sputnik-19 and Sars-Cov-19. Political and religious dilemmas were also one of the reasons individuals restrained from consuming the vaccine. People who identified themselves as a member of a specific political or religious group held negative attitude towards the vaccine. The mentioned barriers show how the pandemic had inevitably struck both the countries and the pitfalls that showed presence during the journey. It can be understood that the healthcare system in both the countries were inadequate, especially with respect to the availability of medical professionals, equipment, and funds for the allocation of resources. Hence, better financing of healthcare system, specialized training of medical professionals, both experienced and freshers, knowledge sharing, and distribution of resources to the neighbouring developing and underdeveloped country, will help foster the development and maintenance of the healthcare resilience system.

Lessons to be learned

The healthcare system in the global arena has acknowledged the significance of a better and standardised infrastructure for barricading the influence of pandemics in future, with special focus on the socio-economic predictors of a 'healthy' medical system. Though both India and European countries have experienced several of its own setbacks, there were events that overcame the test of time. One such example would be the localised managerial system adopted in different parts of European countries and India. Country-independent decisions were taken in European countries that fastened the communication and execution operations, hence improving the quality of health care service to its consumers. In India, a similar exemplary was of Dharavi, a small town in Mumbai that undertook localised control measures that brought about expected positive results within arm length of time. Characterized by its ill-educated and despicable members, this village triumphantly demonstrated the world that a unified resolution among a small number of people could together overcome a newly introduced barricaded that stood across their scope for existence. Healthcare systems were forced to upgrade itself for battling the freshly induced virus, that at the time had no pronounced root. It was still remarkable that the world had joined hands together to deteriorate its presence for a greater global wellbeing. It was reported in Germany that the public medical servants had portrayed a wondrous performance through scanning and identification of the virus contained individuals, precluding its spread to a wider population. Owing to the inadequate quantity of health professionals, a large number of untrained students and workers were hired to constrict the spread of pandemic. Not limiting to this, there was rapid transfer of vaccines from developed countries to developing and the deprived. This ensured the qualitative treatment of a large crowd of the global population. This though ambiguous, appeared to be the major force behind the exile of the virus from the country. The pandemic was an epitome of time-reveal, that challenged the existing norms of life and made agile different sections of the society for a better and stronger tomorrow.

Role of community in building resilient healthcare system

Community resilience is defined as the prioritization of personal, physical, and psychological wellbeing, that would contribute towards fulfilment of societal goals (51). The world as a 'global village' plays a pivotal role in the flourishing of the healthcare system, which was well-observed during the pandemic period. Policies and regulations fashioned in a way that adheres to the cultural beliefs and roles of the general populace has an adverse impact on the efficacy of the healthcare system. Transparency and clarity in communication can drive individuals to follow prescribed rules and behave according to the standard codes of conduct. An example for this would be the weekly Q & A sessions held by the prime minister of India, Narendra Modi to handle the attitude and response of the local audience to the pandemic. Several measures were introduced by him to enhance the sense of communion among the society dwellers, such as the candle lighting and tapping the vessel activity. The attitude the community holds in favour of or against the healthcare system can define the success of the global physical and mental wellbeing. According to Berkes & Ross (2012) (52), a resilient community exhibits the following attributes:

1. **Strong perceived social support** among the community dwellers that unites them to achieve a common predetermined objective.
2. **Learning from past experiences** and drafting interventions to override the earlier mishaps.
3. **Establishing link between people and places**, to enhance the feeling of communion among individuals.





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4. **Active participation in the governance** of the region of residence makes the individual feel themselves as an irreplaceable contributor to the wellbeing of their region.
5. **Unified resolution of societal members** towards solving problems existing in the social and political system of their state or country.
6. **Bridging the differences**, individual or collective can help build better individual and societal identity.
7. Possession of these qualities elevate the scope for a higher quality of partnership between community and the healthcare, thereby promising positive results, even in the most adverse scenarios.

Applying Seligman's 3 P Resilience Model within the community-healthcare system

The founder of Positive Psychology, Martin Seligman had developed the model of resilience, encapsulating 3 elements, personalization, perseverance, and permanence (53). This model though widely used to describe and confront generalized traumatic situations, can be applied specifically within the healthcare system to understand how community and healthcare system can join hands to invigorate physical and mental security of the individuals.

Personalization

This refers to the cognitive misconception that individuals carry with respect to occurrence of an event beyond their control. The tendency of the individual is to either internalize or externalize their locus of control, which further affects the way they confront the event. Sigurvinsdottir et al., (2020) (54) in a study found that those who carried external locus of control had higher levels of anxiety associated with Covid-19 symptoms than those with an internal locus of control, as the latter had pronounced control over the situation. Here, both the community residents and the healthcare system may first scrutinize the event, identify its root cause, and devise plausible solutions that could be executed collaboratively to fight the pandemic. Increased knowledge of the event provides both the parties the opportunity to leverage the benefit of the situation, thereby strengthening their confidence to deal with an event of similar or different nature as it comes.

Perseverance

This refers to the negative unreasonable perception held by the community and healthcare system with respect to the impact of the pandemic. Generalising the spill over of pandemic effects on different areas, may lower their resistance to the situation, making them highly susceptible to its enduring effects. Rather, conceiving an optimistic and realistic perspective of the impact of the pandemic may help them strategize better solutions towards managing the same.

Permanence

It refers to the belief the individual or healthcare sector hold about the length of the traumatizing event. Assumption of a long-lived or permanent pandemic situation can significantly lower the motivation of the community and healthcare sector to invest in its betterment, thereby strengthening the presence of the former. Therefore, restructuring of the belief system of both community and healthcare system workers are essential to thrive in any crises. The resilience model can teach the partakers of the global community-healthcare resilience system to stay vigilant and innovative in their journey of turbulence.

Resultant outcome: Re-establishment of Psychological capital (H.E.R.O)

Psychological capital may be defined as one's belief in their capability to attain their predetermined goals, deal with stressors and fashion life in a way that gratifies their utmost needs and desires (55). It assimilates the four major psychological resources, namely, hope, efficacy, resilience, and optimism (56, 57). It can be postulated that individuals belonging to higher social strata may have higher psychological capital, owing to their access to better physical and mental wellbeing promoters, such as well-paid jobs, quality family life than the other groups. The various themes observed in the previous literature related to psychological capital were a) internalization of positive social response, b) repetition of successful experiences, c) devising new pathways towards achievement of predestined goals, d) exposure to enriching role models that mirror the individuals, and e) transition of negative beliefs and self-concepts to positive ones, that may help dive into a better future (58). This indicates that development of psychological capital within the healthcare system ensures its longevity in success.



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Pariona-Cabrero et al., (2023) (59) studied the impact of psychological capital on the association among physical violence and psychological wellbeing of health care personnels in the aged care facilities. Results depict that the negative experience of trauma may heighten the prevalence of anxiety and depression among healthcare professionals, which however, may be significantly neutralized with the augmentation of psychological capital. Similarly, the work engagement of Chinese Infection Control nurses was positively associated with psychological capital (60). It can be hence deduced that when work engagement increases, the level of resilience may also increase due to increased interest of the nurses in the serving the needs of their patients. Community can also play an important role in empowerment of the healthcare system. As shown in Figure 1, assimilating the components of the Seligman's resilience model and the Psychological Capital, the community-healthcare system resilience can be augmented in the following ways:

Hope

The community and healthcare system develop hope about their capability to handle the unforeseen event with the aid of their previous experiences and knowledge about the situation. Both the community and healthcare system has had their share of positive and negative experiences. Sight of the expected outcome may help them to contribute their efforts in lowering the impact of the situation.

Efficacy

By exerting internal locus of control, it would be possible for the community and healthcare to manage the ambiguity of the situation successfully. Upon careful analysis of the past experiences, it would be easier to identify their strengths and weaknesses that they need to focus on and reorganize, respectively.

Resilience

When the community and healthcare workers understand that the pandemic situation can be dealt with, their capacity to endure the same only widens, thereby expanding their openness towards taking risks and working for a larger positive cause.

Optimism

The beliefs and perceptions the community dwellers and healthcare system hold with reference to the pandemic becomes positive, as they are now capable of handling the situation.

Hence, the community and the healthcare workers may muddle any unforeseen situation, such as the covid-19 pandemic in the future. The combined application of the resilience and the HERO model will help both the global community and the healthcare system to collaboratively develop programs that automates their functionality in such traumatic events.

Limitations

The paper, despite offering few benefits, also has few limitations. Firstly, the cultural differences and other factors that might have affected the difference in the efficacy of healthcare system in India and European countries, was not examined. Secondly, the integrated conception of 3P model of Resilience and Psychological Capital lacks empirical evidence, which may be tested by future researchers.

Relevance of the study

The present study was an attempt to assess the healthcare system resilience of India and European nations. This paper offers the advantage of simultaneous comparison of developed and developing countries, that may be generalized to other countries. Along with the review of the barriers and positive interventions, this paper is also the first which integrates Seligman's 3P model of resilience and Psychological capital model (HERO) within the healthcare context, and may be applied to the global medical system for further assessment of the same. Healthcare workers and policy makers may extract ideas from the study for establishment of a secure physical and psychological world.





CONCLUSION

The paper aimed to understand the healthcare resilience system of India and European countries. The examination of the same culminated in a scoping review of the previous literature covering the interventions that were undertaken by both the countries towards battling the pandemic. Through this study, it can be comprehended that the healthcare system in these countries shared their own strengths and pitfalls during the journey in the pandemic period, and that the collaborative effort in battling the same can generate better results. Covid-19 lend the world global community an opportunity to reflect on and revise the existing status of the healthcare system for a better global wellbeing in the future with the help of the 3P model of resilience and HERO model of the psychological capital.

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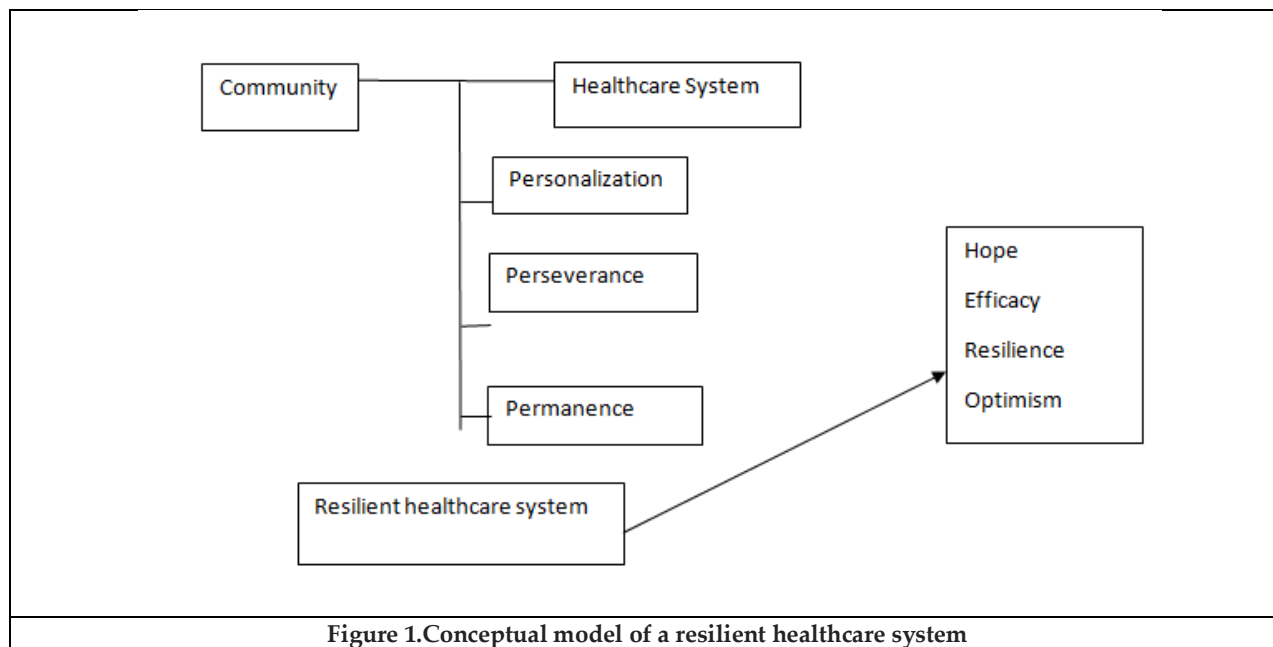


Figure 1. Conceptual model of a resilient healthcare system





A New Approach for Solving ZLPP using Modifiers

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ABSTRACT

Linear programming models play an important role in management, economics, and many industrial applications. LPP with Z-number parameters (ZLPP) can be considered as an extension of fuzzy LPP. In this paper, we convert the Z-linear programming problem to a fuzzy linear programming problem by using the technique of applying modifiers which was proposed by M.Shahila Bhanu and G.velammal[1]. Then the FLP problem can be tackled by using suitable existing methods.

Keywords: Fuzzy sets, Z-number, Ranking function, Triangular Z-number, Fuzzy linear Programming problem, Z-linear programming problem, hedges, and modifiers.

INTRODUCTION

LPP with Z-number parameters (ZLPP) can be considered as an extension of fuzzy LPP. ZLPP has been explored by R.A.Aliev and others [2], Muhammad Akram *et.al* [3], M. Yuan and others [4]. In our previous paper we had proposed a novel approach to ZLPP[5]. M.Shahila Bhanu, G.Velammal [1] and others have studied the problem of applying modifiers to the first component of Z-number. In this paper we give an innovative alternative approach to solving the ZLPP. We convert the Z-linear programming problem to a fuzzy linear programming problem by using modifiers. Then the FLP problem can be tackled by using suitable existing methods.

Preliminaries

Definition: Fuzzy set

A fuzzy set A is defined on a universe X may be given as: $A = \{(x, \mu_A(x)) | x \in X\}$, where $\mu_A(x): X \rightarrow [0,1]$ is the membership function of A. The membership value $\mu_A(x)$ describes the degree of belonging of $x \in X$.





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Definition: Triangular fuzzy number

A fuzzy number $\tilde{A} = (a, b, c)$ is a triangular fuzzy number if its membership function is given

$$\text{by } \mu_{\tilde{A}}(x) = \begin{cases} \frac{x-a}{b-a} & a \leq x \leq b \\ \frac{c-x}{c-b} & b \leq x \leq c \\ 0 & c \leq x \leq d \end{cases}$$

Definition: Ranking function

Let $F(R)$ be a set of fuzzy numbers defined on set of real numbers. A ranking function is a function $\mathfrak{R}: F(R) \rightarrow R$, which maps each fuzzy number into the real line.

Definition: Zadeh's definition of z-number

AZ-number is an ordered pair of fuzzy numbers $Z = (A, B)$, associated with a real valued uncertain variable X , with the first component A , a restriction on the values which X can take and the second component B , a measure of reliability of the first component.

Definition: Triangular Z-number

In the Z-number $Z = (A, B)$, if the two component A, B are triangular fuzzy number, then the corresponding Z-number is called a Triangular Z-number.

Definition: MIN R Type operation

Let $* \in \{+, -, \times, /\}$, the MIN R operation on the set of all continuous Z-number is defined to be

$(A, B) (*, \text{MIN})(C, D) = (A * C, \text{MIN}(B, D))$, where $A * C$ is calculated by using the extension principle and

$$\text{MIN}(B, D) = B \text{ if } R_k(B) < R_k(D)$$

$$D \text{ if } R_k(D) < R_k(B)$$

Definition: Sum of two Triangular Z-numbers by MIN R

Let $Z_1 = (A_1, B_1)$ & $Z_2 = (A_2, B_2)$ be any two Triangular Z-numbers, then

$$Z_1(+, \text{MIN})Z_2 = (A_1, B_1)(+, \text{MIN})(A_2, B_2) \\ = (A_1 + A_2, \text{MIN}(B_1, B_2))$$

Definition: Linguistic Hedge and Modifier

Linguistic hedges are special linguistic terms by which other linguistic terms are modified. Linguistic terms such as very, more or less, fairly, or extremely are examples of linguistic hedges. A linguistic hedge, H , may be applied to a fuzzy set by using a unary operation, h defined on the unit interval $[0, 1]$.

A unary operation, which is an increasing bijection, representing a linguistic hedge is called modifier.

If $\mu_A(u)$ is the membership function of a fuzzy set A then a linguistic hedge H can be applied to A by using the appropriate modifier h by the equation,

$$\mu_{HA}(u) = h(\mu_A(u)).$$

Note:

- If $h(a) < a$ for all $a \in [0, 1]$, the modifier is called strong.
- If $h(a) > a$ for all $a \in [0, 1]$, the modifier is called weak.
- The modifier $h(a) = a$ for all $a \in [0, 1]$, is called an identify modifier.
- Every modifiers h satisfies the following conditions:
 - * $h(0) = 0$ and $h(1) = 1$.
 - * h is a continuous function.
 - * if h is strong, then h^{-1} is weak and vice versa.





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- * given another modifier g , composition of g with h and h with g are also modifiers and, moreover, if both h and g are strong (weak). Then so are the compositions.

Converting ZLPP to FLPP using modifiers

Consider the sentence "Vijay has a good chance of getting very high marks in maths exam".

This can be written in the form of Z-valuation

$X \text{ isz } (A, B)$

where X denotes the variate "maths mark of Vijay"

A denotes the fuzzy set "very high marks"

B denotes the fuzzy set "good chance"

Now we want to rewrite the sentence as "Vijay has a very good chance of getting _____ marks in maths exam".

In other words we want to find A' such that

$X \text{ isz } (A', B')$

where B' is the fuzzy set representing the fuzzy set "very good chance". This is the problem of applying modifiers to first component in Z-valuation. M. Shahila Bhanu have studied this problem.

Hence statement $X \text{ isz } (A, B)$ is considered equivalent to the statement $X \text{ isz } (A', B')$. So we can replace the Z-valuation (A, B) by (A', B') . So this technique of applying modifiers can be used to convert ZLPP into FLPP.

Consider the following ZLPP

Min $c_1 x_1 (+, \min) c_2 x_2$

Subject to

$a_{11} x_1 (+, \min) a_{12} x_2 \geq b_1$

$a_{21} x_1 (+, \min) a_{22} x_2 \geq b_2$ (1)

$x_j \geq 0$

where $c_1 = (c_{11}, c_{12}) = ((75, 80, 85), \text{likely})$

$c_2 = (c_{21}, c_{22}) = ((50, 60, 70), \text{very likely})$

$a_{11} = (A_{111}, A_{112}) = ((8, 10, 12), \text{very likely})$

$a_{12} = (A_{121}, A_{122}) = ((4, 6, 8), \text{very likely})$

$b_1 = (B_{11}, B_{12}) = ((180, 200, 220), \text{very likely})$

$a_{21} = (A_{211}, A_{212}) = ((6, 8, 10), \text{very likely})$

$a_{22} = (A_{221}, A_{222}) = ((8, 10, 12), \text{very likely})$

$b_2 = (B_{21}, B_{22}) = ((290, 300, 310), \text{likely})$

Hence except for c_1 and b_2 and all other parameters have "very likely" as their second component.

So if apply modifiers and find c'_{11} and B'_{21} such that

$c_1 = (c_{11}, \text{likely}) \sim (c'_{11}, \text{very likely})$ and

$b_2 = (B_{21}, \text{likely}) \sim (B'_{21}, \text{very likely})$

Then we get a ZLPP where all parameters have "very likely" as their reliability component

So we then have the ZLPP

Min $c'_1 x_1 (+, \min) c_2 x_2$

Subject to

$a_{11} x_1 (+, \min) a_{12} x_2 \geq b_1$

$a_{21} x_1 (+, \min) a_{22} x_2 \geq b_2$

$x_j \geq 0$

where $c'_1 = (c'_{11}, \text{very likely})$ and $b'_2 = (B'_{21}, \text{very likely})$ so this can be converted to fuzzy LPP

Min $c'_{11} x_1 + c_2 x_2$

Subject to

$A_{111} x_1 + A_{121} x_2 \geq B_{11}$

$A_{211} x_1 + A_{221} x_2 \geq B_{21}$

$x_j \geq 0$.

The reliability of this system is "very likely"

By modifier technique $c'_{11} = ((70, 80, 90), (.85, .9, .95))$,

$B'_{21} = ((275, 300, 325), (.85, .9, .95))$





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So the ZLPP (1) is converted to the following ZLPP

$$\text{Min}((70,80,90), (.85, .9, .95))x_1 (+, \text{min})((50,60,70), (.85, .9, .95))x_2$$

Sub to

$$((8,10,12), (.85, .9, .95))x_1 (+, \text{min})((4,6,8), (.85, .9, .95))x_2$$

$$\geq ((180,200,220), (.85, .9, .95))$$

$$((6,8,10), (.85, .9, .95))x_1 (+, \text{min})((8,10,12), (.85, .9, .95))x_2$$

$$\geq ((275,300,325), (.85, .9, .95))$$

$$x_i \geq 0$$

Next we convert the given ZLPP into FLPP

$$\text{Min}(70,80,90)x_1 + (50,60,70)x_2$$

Subject to constraints

$$(8,10,12)x_1 + (4,6,8)x_2 \geq (180,200,220)$$

$$(6,8,10)x_1 + (8,10,12)x_2 \geq (275,300,325)$$

$$x_1, x_2 \geq 0$$

The reliability of this system is (.85, .9, .95)

We can convert the above FLPP into the following LPP using the method of Klir and Yuan [6]

$$\text{Min } 80x_1 + 60x_2$$

Subject to constraints

$$8x_1 + 4x_2 \geq 180$$

$$6x_1 + 8x_2 \geq 275$$

$$10x_1 + 6x_2 \geq 200$$

$$8x_1 + 10x_2 \geq 300$$

$$12x_1 + 8x_2 \geq 220$$

$$10x_1 + 12x_2 \geq 325$$

$$x_1, x_2 \geq 0$$

Since the objective function is minimization, we convert it into maximization using

$$\text{Min } Z = -\text{Max } (-Z)$$

$$\text{Max } z = -80x_1 - 60x_2$$

Subject to constraints

$$8x_1 + 4x_2 \geq 180$$

$$6x_1 + 8x_2 \geq 275$$

$$10x_1 + 6x_2 \geq 200$$

$$8x_1 + 10x_2 \geq 300$$

$$12x_1 + 8x_2 \geq 220$$

$$10x_1 + 12x_2 \geq 325$$

$$x_1, x_2 \geq 0$$

The solution to the problem is obtained by using Two-phase method

The initial simplex table is given by

		c_j	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1
c_B	Basis	x_B	x_1	x_2	s_1	s_2	s_3	s_4	s_5	s_6	R_1	R_2	R_3	R_4	R_5	R_6	
-1	R_1	180	8	4	-1	0	0	0	0	0	1	0	0	0	0	0	
-1	R_2	275	6	8	0	-1	0	0	0	0	0	1	0	0	0	0	
-1	R_3	200	10	6	0	0	-1	0	0	0	0	0	1	0	0	0	
-1	R_4	300	8	10	0	0	0	-1	0	0	0	0	0	1	0	0	
-1	R_5	220	12	8	0	0	0	0	-1	0	0	0	0	0	1	0	
-1	R_6	325	10	12	0	0	0	0	0	-1	0	0	0	0	0	1	

		c_j	-80	-60	0	0	0	0	0	0
c_B	Basis	x_B	x_1	x_2	s_1	s_2	s_3	s_4	s_5	s_6
0	s_3	53	0	0	$-\frac{11}{10}$	$-\frac{1}{5}$	1	0	0	0





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0	s_4	48	0	0	$-\frac{1}{10}$	$-\frac{6}{5}$	0	1	0	0
0	s_5	106	0	0	$-\frac{6}{5}$	$-\frac{2}{5}$	0	0	1	0
0	s_6	96	0	0	$-\frac{1}{5}$	$-\frac{7}{5}$	0	0	0	1
-80	x_1	$\frac{17}{2}$	1	0	$-\frac{1}{5}$	$\frac{1}{10}$	0	0	0	0
-60	x_2	28	0	1	$\frac{3}{20}$	$-\frac{1}{5}$	0	0	0	0
	z_j	-2360	-80	-60	7	4	0	0	0	0
	$z_j - c_j$		0	0	7	4	0	0	0	0

The solution to the above simplex method is given by

Since all $z_j - c_j \geq 0$, the current basic feasible solution is optimal and the solution for the LPP is as follows: $x_1 = \frac{17}{2}, x_2 = 28$ and Max $Z = -2360$.

Therefore Min $Z = -\text{Max}(-Z) = 2360$.

The solution to the FLPP is $x_1 = \frac{17}{2}, x_2 = 28$ and

$$\text{Min} = (70, 80, 90) \frac{17}{2} + (50, 60, 70) 28 = (595, 680, 765) + (1400, 1680, 1960) \\ = (1995, 2360, 2725)$$

The solution to the ZLPP is $x_1 = \frac{17}{2}, x_2 = 28$ and Min = $((1995, 2360, 2725), (.85, .9, .95))$

CONCLUSION

An innovative approach to solve ZLPP by using modifiers has been provided in this paper. Here we have demonstrated the approach by a numerical example.

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Kaantham [Magnetic Oxide of Iron]. - An Effective Siddha Mineral Single Drug – A Review

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ABSTRACT

Under Materia Medica the Siddha system deals with the combination of Herbs, Minerals Metals and Animal and Marine products. Herbal remedies are mostly used to treat the diseases. When herbal therapies are ineffective, metals and minerals are utilised instead. This could be known by the verse

“Verpaaru thazhaipaar minjinakkaal mella mella

Parppam chenduram paarae”

Agathiyar pininool – 80^[1].

This paper focuses on origin, character, purification and processing techniques and medicinal uses of Siddha mineral drug kaantham.

Keywords: Kaantham, Siddha mineral drug, Magnetic oxide of iron

INTRODUCTION

Siddha system of medicine is originated from Lord Shiva, the supreme God and he is also considered to be chief of Siddhars and chief of sangam poets. The drugs that the Siddhars used could be divided into three categories: Mooligai [herbal product], Thathu [inorganic substances], and Jeevam or Sangamam [animal products]. In that the Thathu drugs are further classified as: 1. Uppu [Salts], 2. Pashanam [Arsenicals], 3. Loham [Heavy metals], 4. Rasam [Mercury and its salts], and 5. Ghandhagam [Sulfur alone]. Kaantham comes under ulogam [2]. Almost all the





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Siddhars in their works have stated that information about kaantham, purification of kaantham and its indication, for the medicinal usage with the adjuvant.

Geographical Distribution

In modern, kaantham is compared as Magnetic oxide of iron or Magnetite. Magnetite is the natural magnet. It contains both ferrous and ferric iron. 'Magnetite' was named after the Magnesia region of Thessaly, Greece, the home of the Magnets and an important centre of iron production. The historical importance of this region's mineral deposits is reflected by two elements, magnesium and manganese, which were also named for this region[3]. Distribution of magnetite are Karnataka 73%, Andhra Pradesh 14%, Rajasthan 5%, TamilNadu 4.9% Rest in Assam, Bihar, Goa, Jharkhand, Kerala, MH, Meghalaya and Nagaland[4].

Other Names

Lode stone, Magnetic iron ore

Physical Properties Of Magnetite [5]

Chemical Classification	Oxide
Color	Black to silvery gray
Streak	Black
Luster	Metallic to submetallic
Diaphaneity	Opaque
Cleavage	None
Mohs Hardness	5 to 6.5
Specific Gravity	5.2
Diagnostic Properties	Strongly magnetic, color, streak, octahedral crystal form.
Chemical Composition	Fe ₃ O ₄
Crystal System	Isometric

The Economic Importance of Magnetite

It is used as a raw material for manufacturing steel in iron and steel industries. Magnetite is frequently used to identify magnets and magnetic fields because of its ability to attract magnets. As magnetite is used to produce electricity, it is a crucial material component of power plants.

Hematite and magnetite are by far the two most significant iron ores in terms of commercial value. While hematite is more common than magnetite, magnetite iron ore deposits are highly prized due to magnetite's higher iron content. Without these two ores, human society would literally not have made it to the Iron Age, much less to modern civilization[6]. Magnetite is also a significant source of iron, with 40% of the world's iron derived from it. Magnetite contains a high proportion of iron, with an average content of 72.4%, which is higher even than hematite. Magnetite is also notable for its strong magnetic properties, which are extremely useful during mineral beneficiation. [6].

REVIEW OF SIDDHA LITERATURE

Synonyms of kaantham: [7].

- Sivaloga Sevagan
- Dharanikku Natham
- Sootha Angusam
- Navaloga Thuratti





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- Kayasiththikku Paathiravan
- Murugan Puranam

Classification Of Kaantham [8].

1. Pramugam - "That variety which makes all kind of iron move about"
2. Kambagam - "That which attracts any other piece of iron"
3. Karshagam - "That which repels another piece of iron"
4. Thiravagam - "That which can at once melt other sorts of Iron"
5. Romagam - "That which when broken shoots forth hair-like filaments"

Pramugam and Kambagam are useful for preparing medicine to the disease conditions. Karshagam and Thiravagam are very useful for the general health of the body. Romagam is used for making Rasa kattu.

Specialities of kaantham [9].

Theraiyar said that kaantham is better than iron in the treatment of diseases.

"Irumbinum kaantham menmai kaan"

-Gunapadam thaathu jeeva vaguppu.

Milk boiled in the magnetic vessel has haematinic action. If milk is boiled in the magnetic vessel it does not brim out of the vessel which is the pivotal characteristic feature of magnet. The preparations using magnetic vessels for life prolongation has been mentioned in Siddha literature.

Special Mentions

In Agathiyar vaiithiya rathina surukkam, kaantham is one of the "Thiriloga chenduram"

"Kelappa thiriloga chendurathai

Kettiyaam logam abragam kaantham"[10].

It is also one of the "Panchaloga chenduram"

"Kelada panjaloga chenduraththai

Kedilla thangamodu velli chembu

Naalada kaanthamodu irumbu ivvainthum

Nalamaga suthi seithu sariyaai kootti"[11].

Bohar has included Kaantham as one among 120 uparasams. He has stated this as,

"Kandukol uparasathin vagaiyai solven

Kaanthamodu abiragam thurusu kannar"[12].

Common Characters [13].

In Padhartha Guna Chinthamani, the Indications for kaantham are sobai [Anasarca/Oedema], kunmam [Acid peptic diseases], kaamalai [Jaundice], megam [Veneral diseases], Paandu [Anaemia], Thirithodam [Diseases of three humours], Vettai [Leucorrhoea], Seetham [Respiratory disease], Pasi [Increased Appetite], Uthara noi [Gastro-intestinal diseases], Kanno [Eye diseases], Premegam [Gonorrhoea]. and which have been studied as below,

"Kaanthathal sobaigunmam kaamilamegampaandu

Sernthathirithodam vettaiethangaal - ointhaasi

Paerutharam kannoi pramiyaneeramaiyum pom

Oriniraiyaayulurum un"

In the form of chenduram, kaantham is very useful for the diseases such as Pandu [Anaemia], Kamalai [Jaundice], Suram [Fever], Vaanthi [Vomiting], Unthivali [Abdominal Pain], Athisaram [Diarrhoea]. and Kasamswasam [Bronchial Asthma]. as studied in Padhartha Guna Chinthamani.

"Kaantha chenduram karuthariya unthivali

Pontha athisaaram povathandri vaanthikaba

Kaasasvasa vinai kaamalai paanduvodu

Poosalidum noianaithum pom".



Siva Lakshmi *et al.*,**Special properties of Kaantham [14].**

Consumption of milk boiled in a vessel made up of magnetic oxide of iron, improves blood and strengthens the body. The boiled milk never spill over the magnetic vessel.

Taste[15].

- Astringent in taste. Some sour, bitter.

Potency[16].

- Hot

Actions [17].

- Haematinic
- Alterative
- Stomachic
- Nutrient

Synergetic Drug[18].

Ayam [Iron], Velli [Silver], Nagam [Zinc], Chembu [Copper], Pooram [Calomel], Kanthagam [Sulphur], Thangam [Gold], Vangam [Lead], Karpooram [Camphor]..

Antagonist Drug[19].

Navacharam [Ammonium chloride], VEDIUPPU [Potassium nitrate], Thurusu [Copper sulphate], Apragam [Mica], Vengaram [Borax], Venkalam [Bronze], Nimilai [Bismuth], Veeram [Mercuric chloride], Manosilai [Red orpiment], Gowri [Arsenic penta sulphide], Silasathu [Asphaltum], Pooneeru [Fullers earth], Mirutharsingi [Lead monoxide]..

Purification Methods [20].

- Boil the kaantham with kadineer and horse gram decoction. Then wash with water.
- Soak the kaantham in lemon juice, kadi, buttermilk respectively for 3 days and wash it.
- Boil the kaantham in lemon juice, kadi and then soak it, in the juice of cow dung for 7 times.
- Kaantham is red hot heated in furnace, dipped in the kollu decoction for 7-21 times.

Kaantham Preparations

S.No	Kaantham Preparations	Dose	Adjuvant	Indication	Reference
1.	Kaantha Parpam	1-2 kundri [130-260 mg].	Poonduthailam, milagu thailam, thulasi chaaru	Piththa pandu [Anaemia], manjal noi [Jaundice], perunkazhichal [Diarrhoea], veppu pini, raththa kasa noi, maarbu noi [Cardiac illness], pakka noi	Anubava vaithiya navaneetham
2.	Kaantha Parpam	¼ kundri [32.5mg].	Water, Hot water, Ullipoonduthylam, Milagu thylam, Thulasi chaaru, ruthratchai	Vadham, Peruvayiru [Acities], Pallai, Pitham, paandu [Anaemia], Paithya sanni, Maha sanni, Kaamaalai [Jaundice], kabam, Pakka soolai, Kuttam [Skin diseases],	Gunapadam thathu jeeva vaguppu, Page no – 131





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			juice, Honey	Kaichchal [fever], Veppa pini, Athgi uppusam, Paarisa vaayu [Hemiplegia], Iraippu [Bronchial asthma], Porumal, Maradaippu [Cardiac illness], Mega kaangai, Yoni putru [Vaginal cancer], Linga putru [Carcinoma of penis], Moola pini [Haemorrhoids], Powthram [Fistula].	
3.	Kaantha Parpam	Kadugu [5mg], Thinai [2mg], Nel [18mg], Kundri [130mg].	Honey, Ghee, Vellam, Seenthil Uppu	Asathi [Malaise], Sethma suram, Ratha kaasam, ulai maanthai, Achcharam [Oral candidiasis], Swasam [Bronchial asthma], Vadha suram [Fever].	Gunapadam thathu jeeva vaguppu, Page no – 136
4.	Kaantha Chenduram	Panavedai [455 mg].	Honey	Piththa pandu [Anaemia], visha pandu [Anaemia], sogai, kavisai katti, neerambal, anda vaayu [Scrotal swelling], anadha vaayu	Gunapadam thathu jeeva vaguppu Page no – 142
5.	Kaantha Chenduram	1-2 kundri [130-260mg].		Pandu [Anaemia], kai kaal veekkam [Odema], nalir suram [Rigor].	Gunapadam thathu jeeva vaguppu Page no – 143
6.	Kaantha Chenduram	3-4 kundri [390-520 mg].		Pandu [Anaemia], manjal noi [Jaundice], sogai [Odema].	Anubava vaiithiya navaneetham, Part-1 Page no – 61
7.	Kaantha Chenduram	3-4 kundri [390-520 mg].	Equal amount of elarisi, kasakasa, narseeragam, milagu made into powder and 1/4 th of the mixture is taken along with ghee or butter.	Piththa Pandu [Anaemia], manjal noi [Jaundice], sogai [Oedema], kirani, moola vaayu, aasiga vaayu	Anubava vaiithiya navaneetham, Part-1 Page no – 62
8.	Kaantha Chenduram	1 kundri [130 mg].	Honey	Pandu [Anaemia], sogai [Oedema], kaamalai [Jaundice], veppu, piththa suram	Anubava vaiithiya deva ragasiyam, Page no – 381





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				[Fever], venmagam [Cancer].	
9.	Kaantha Chenduram	100mg	Honey	Pandu[Anaemia], sogai, kaamalai[Jaundice], madhumegam[Diabetes mellitus].	Kannusamy paramparai vaithiyam Page no – 37
10.	Rathathi Chooranam	3 Panavedai [1.48g].	Honey	Pandu[Anaemia], Sogai [Oedema], kaamalai[Jaundice], kulir [Rigor].	Sarabendra vaithiya muraigal pandu, kaamalai sigichai Page no – 15
11.	Mandoora chenduram		Honey	Pitha Pandu[Anaemia],sogai [Oedema], kaamalai[Jaundice], pitham, mahotharam, irumal [Cough], peru vayiru [Acities].	Sarabendra vaithiya muraigal pandu, kaamalai sigichai Page no – 30
12.	Kaanthathi Mandoora chenduram		Ghee	Piththa Pandu [Anaemia],sogai [Oedema], kaamalai[Jaundice], mahotharam, irumal [cough].	Sarabendra vaithiya muraigal pandu, kaamalai sigichai Page no – 30
13.	Elumicham pazha legiyam	Kazharchikaai [2.70g].		Pandu[Anaemia], kaamalai[Jaundice], vaanthi[Vomit], ilaippu [Tuberculosis].	Sarabendra vaithiya muraigal pandu, kaamalai sigichai Page no – 40
14.	Karippaanathi legiyam	Kottai paakku alavu[6.02g].	Honey	Piththa Pandu[Anaemia], visha pandu [Anaemia],kaamalai [Jaudice], kunmam [Acid peptic diseases], piththam	Sarabendra vaithiya muraigal pandu, kaamalai sigichai Page no – 52
15.	Arappodiyathi vadagam	Puliyam kottai alavu [700-800mg].	Karisalai charu	Piththa Pandu[Anaemia],sogai [Oedema].	Sarabendra vaithiya muraigal pandu, kaamalai sigichai Page no – 56
16.	Legiyam-Paandu	Pakkalavu [6.02g].	Karisalai charu	Piththa Pandu[Anaemia], visha pandu[Anaemia],kaamalai [Jaudice].	Sarabendra vaithiya muraigal pandu, kaamalai sigichai Page no – 62
17.	Kittathi Chooranam	Mooviral alavu	Hot water	Pandu[Anaemia],kaamalai [Jaundice], veekkam [Swelling].	Sarabendra vaithiya muraigal pandu, kaamalai sigichai Page no – 80





18.	Venkaara maathirai	500mg		Pandu [Anaemia], Andavaatham [Scrotal swelling]..	Siddha vaithya thirattu age no – 45
19.	Arumuga chenduram	½ to 1 kundri [60-130 mg].	Thirikadugu chooranam	Paandu [Anaemia], Sogai, [Odema].Kamaalai [Jaudice], Arai vaatham, Virai vaatham [Scrotal swelling], Vedi soolai	Siddha vaidhya thirattu Page no 135
20.	Suyamaakini chenduram	100-200mg	Thirikadugu chooranam	Arai vaatham, Virai vaatham [Scrotal swelling], Vedi soolai	Siddha vaidhya thirattu Page no 135
21.	Salamanjari chenduram	200-500mg	Honey	Paandu [Anaemia], Neerambal, Veekkam [Swelling], Sogai [oedema].	Yugi Karisal Page no 151
22.	Thiriloga vadagam	Thuthuvalankai alavu	Milagu charu, Inji chaaru, Chukku kashayam	Paandu [Anaemia], Envagai gunmam [Acid Peptic diseases], Kaamalai [Jaundice].	Agathiyar vaidhya vallathi 600 page no 46
23.	Suyamakini chenduram	1-1 ½ kundri [130 mg-190 mg].	Honey, Ghee, Butter	Paandu [Anaemia], Sogai [Odema], Araiyaapu, Seriyaamai [Indigestion].	Agathiyar pallu 200 page no 24
24.	Ayakaantha chenduram	100-200mg	Honey, Ghee, Pancha deepaakini chooranam	All types of paandu [Anaemia], Oothal noigal [all Oedema conditions].	Agathiyar chenduram 300 page no 135
25.	Rasaloga chenduram	Kundri [130 mg].	Honey	Paandu [Anaemia], Kaamalai [Jaundice], Sanni [Delirium], Soolai [Pain].	Agathiyar vaidhya rathna surukkam page no 120
26.	Boopathi chenduram	Oru Maa alavu	Honey	Paandu [Anamia], Kaamalai [Jaundice], Sogai [Odema], Murai suram [Fever].	Sarabendra vaidhya muraigal-Paandu, Kaamalai sikichai page no 20
27.	Sinjathi Kuzhambu	Lemon size	Honey	Paandu [Anaemia], Eri kaamalai [Jaundice], Suzhal kaamalai	Sarabendra vaidhya muraigal-Paandu, Kaamalai sikichai page no 15
28.	Karippaanaathi legiyam	Kottai paakkalavu [6.02g].	Honey	Piththa paandu [Anaemia], Kaamalai [Jaundice], Gunmam [Acid Peptic diseases].	Sarabendra vaidhya muraigal-Paandu, Kaamalai





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					sikichai page no 52
29.	Magavasantha kusumakaram	kundri alavu[130 mg].	Thiriphala chooranam	Paandu [Anaemia].	Siddha vaidhya thirattu
30.	Kushta kaja kesari	Payaralavu [65 mg].	Honey, sarkarai [sugar].	Kushtam [Leprosy]., Megam [Veneral diseases].	Siddha vaidhya thirattu
31.	Thiriloga ratchasan	kundri alavu[130 mg].		Megam [Veneral diseases]., Kshayam [Tuberculosis].	Siddha vaidhya thirattu
32.	Navalogakkini kumaaran	kundri alavu [130 mg].		Fever, Sanni [Delirium]., nadukkal [Tremor]., kulir [Rigor]., naavaratchi [Dryness of tongue]., thimir [Itching].	Siddha vaidhya thirattu
33.	Vatha ratchasan maathirai	3 varagan [12.6 g].	Honey	Sanni [Delirium]., Thosam, vaatham	Agathiyar vaidhya rathna surukkam
34.	Vishnu chakra maathirai	Kundri [130 mg].	Honey, Thirikadugu, Ginger juice	Pakka vaatham [Hemiplegia]., Sobai [Dropsy/Oedema]., Sanni 13[Delirium]., Yeppam [Belching]., Moorchai, Vaayu	Agathiyar vaidhya sillarai kovai
35.	Karba kuzhambu	2-3 kundri [260-390 mg].	Appropriate adjuvant	Karba soolai, Karba kirumi, Karba vipruthi [Uterine disorders].	Agathiyar vaidhya pillai thamizh Page no 141
36.	Ozhi kaalan maathirai	Kundri [130 mg].	Honey	Vaanthibethi [Cholera].	Siddha vaidhya thirattu
37.	Kshaya kulanthaga chenduram		Thirikadugu. Honey	Shayam [Tuberculosis]., Kaasam [Cold]., Swasam [bronchial asthma]., Kaba noigal [Respiratory disorders].	Siddha vaidhya thirattu
38.	Karuppu vishnuchakkara maathirai	1to2 maathirai	Breast milk,/honey	Anda vaatham [Scrotal diseases].,thimir vaatham, gunmam[Acid peptic diseases].,kuttam [Skin diseases].,paarisa vaatham[Hemiplegia]., ilampillai Vaatham [Polio diseases].	Veeramamuni vaagada thirattu Page no – 14
39.	Uthamani kaamaran	Ulundhalavu [65 mg].	Honey, Water	Vatha sanni [Delirium]., Pitha sanni [Delirium]., Suram [Fever].	Agaththiyar vaidhya sindhamani page no 358
40.	Panchaloga villai	Pungan vidhai		Sala rogam [Urinary tract disorders]., Mega vaivu [Veneral diseases].	Yagobu vaidhya sindhamani 700 Page no 190





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41.	Kaantha villai	Kundrimani [130 mg].	Honey, Panai vellam [palm jaggery]., Sarkarai [sugar].	Linga putru [Carcinoma of penis]., Yoni putru [carcinoma of vagina]., Kanna putru [Buccal carcinoma].	Veerama munivar vaagada thirattu page no 89
42.	Agnikumaara chenduram	1-2 kundri [130 mg-260 mg].	Honey, Ghee, Ginger surasam	Gunmam [Acid peptic diseases]., Mahotharam [Anasarca]., Thasai kattigal	Veeramamunivar vaagada thirattu
43.	Panchamirtha chenduram	1-2 Arisi [65 mg].	Honey	Perumpaadu [Menorrhagia]., Venkuttam [Leucoderma]., Vettai [Leucorrhea].	Sarabenthira vaidhya rathnavali Page no 75
44.	Kumatti mezhugu	200-500 mg	Palm jaggery	Gunmam [Acid peptic diseases]., Magotharam [Ascites]., Kavisai	Agathiyar vaidhya kaaviyam 1500 Page no 150
45.	Vaan mezhugu	100-200mg	Palm jaggery	Peruvayiru [Ascites]., Neerizhivu [Diabetes mellitus]., Kalladaippu [Renal calculi].	Yugi karisal Page no 151
46.	Pattu karuppu	50-100 mg	Honey	Soothaga soolai, Soothaga sanni, Soothaga vettai [Uterine disorders].	Siddha vaidhya thirattu Page no 162

Scientific Validation**In vitro Study****Anti-bacterial activity of Kaantha Rasa Vilai by in-vitro methods: [21]**

Antibacterial activity was determined against certified strains of *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, using a modification of agar diffusion assay method[26]. Discs of 6 mm diameters were used. Microorganisms were inoculated on nutrient broth [Himedia, Bombay]. for 24h at 37°C. The inoculate absorbance was established between 0.08 and 0.10 AU [equivalent to 0.5 McFarland 108 CFU/ml]. adding sterile nutrient broth, before incorporating bacteria [$\lambda=625$ nm]. Bacterial strains were seeded on Muller-Hinton agar. The sterile discs were impregnated in the seeded agar. From the stock solution, *Kaantha Rasa Vilai* at concentration of 200mg/ml was taken. A disc of Streptomycin [20 μ g/disc]. was used as a positive control. For 24 hours, the plates were incubated at 37°C. Each experiment was performed three times. The diameter of the growth inhibition zone was measured with standard zone reader scale [Himedia, Bombay]. and recorded the mean diameter. *Kantha rasavillai* had a strong anti-bacterial activity against *S.aureus*, *Vibrio cholerae* and *K.pneumoniae* at 5 μ l, 10 μ l, 15 μ l, 20 μ l concentrations and mild antibacterial activity against *E.coli*, and *S.typhi* at 10 μ l and 20 μ l concentrations.

Anti-fungal activity of Kaantha Rasa Vilai by in-vitro methods: [22]

Antifungal activity was carried out by Kirby Bauer disc diffusion method against *Candida sp.*, *Aspergillus niger*, *Trichoderma rubrum*, *Aspergillus flavus*, *Aspergillus fumigatus*. The microorganisms were inoculated on Potato dextrose broth [Hi-media, Bombay]. for 24 hat 25°C. The inoculate absorbance was established between 0.08 and 0.10 AU [equivalent to 0.5 McFarland 108CFU/ml]. adding sterile Potato dextrose broth, before incorporating fungi [$\lambda=530$ nm]. Fungal strains were seeded on Potato dextrose agar with 4% glucose. The seeds were impregnated with the sterile discs. From the stock *Kaantha Rasa Vilai* 200mg/5ml of concentration was taken. The sterile discs were loaded with 40 μ l of test drug. Fluconozol [100 μ g/disc]. antifungal agent was used as positive control. The plates were incubated at 25°C for 48h. All the assays were carried out in triplicate. The diameter [mm]. of the growth inhibition zone was measured with standard zone reader scale [Himedia, Bombay]. and recorded the meandiameter. *Kaantha*





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Rasa Vilai had moderate activity against the fungal strains [i.e.]. *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Candida albicans* sp. and *Trichophyton rubrum* at 20 μ l and 40 μ l for *Kaantha Rasa Vilai*. The drug was potentially against the fungal pathogen even in lesser concentrations.

Preclinical study on kaantham preparations

Effect of kaantha chenduram on indomethacin induced gastric ulcer lesions in rats [23].

Wister albino rats were divided into 4 groups of 6 animals each. They were fasted for 24 hours then the standard drugs and test drugs were administered orally. half an hour before the oral administration of indomethacin [25mg/kg]. Group I – served as solvent control [0.3% carboxy methyl cellulose sodium]. Group II– received sucralfate [270mg/kg]. Group III –received kaantha chendooram [20mg/kg]. Group IV –received kantha chendooram [40mg/kg]. Six hours later animals were sacrificed using ether anesthesia. The stomach mucosa was separated and the ulcer index was calculated according to Asuzu and omu, 1990. Results were kaantha chendooram at the dose level of 20mg/kg and 40mg/kg produced a significant decrease in the ulcer index [$p < 0.01$]. The activity of both dose levels was comparable and equipotent as that of sucralfate treated group [$p < 0.01$]. There is a significant increase in the mucin content of the gastric mucosal tissues at both dose levels and which also comparable and equipotent as that of sucralfate treated group [$p < 0.01$].

Anti-diabetic activity of Ayakaandha abraga chenduram on streptozotocin induced diabetes in rats [24]

Rats were divided into 4 groups of 6 animals each. After overnight fasting, diabetes was induced by intra peritoneal injection of streptozotocin [STZ]. dissolved in 0.1 M cold sodium citrate buffer, pH 4.5, at a dose of 55 mg/kg [Aslam et al., 2007]. The control rats received the vehicle alone. The animals were allowed to drink 5% glucose solution overnight to overcome the drug-induced hypoglycemia. After 1 week time forth development of diabetes, the rats with moderate diabetes having hyperglycemia [blood glucose range of above 200 mg/dl]. were considered as diabetic rats and used for the experiment. Group I – Normal control [Non – diabetic]. received distilled water 1ml/kg PO for 14 days. Group II– diabetic rats received distilled water 1ml/kg PO for 14 days. Group III – diabetic rats received Standard drug Glibenclamide 5mg/kg PO for 14 days. Group IV - diabetic rats received 25mg/kg of *Ayakaandha Abraga Chenduram* for 14 days. Blood was withdrawn from tail vein on 0, 4th, 7th and 14th day of drug administration and glucose levels were measured using glucometer. Oral administration of AAC [25mg/kg]. significantly reduced the elevated blood glucose levels as the duration of drug administration increases. On 4th day, AAC significantly [$P < 0.05$]. reduced the blood glucose level as compared to control. On 7th and 14th day of treatment, AAC significantly [$P < 0.01$ and $P < 0.001$, respectively]. decreased the blood sugar levels compared to diabetic control. The reference control, glibenclamide showed significant [$P < 0.001$]. reduction in blood glucose from 4th day onwards. On 14th day both AAC and glibenclamide showed similar antidiabetic effect against STZ induced hyperglycaemic effect. The results indicated P value < 0.05 and so it is considered to be significant.

CONCLUSION

Based on this review, kaantham possesses anti-bacterial, antifungal anti-diabetic activity and traditionally used to prepare lot of Siddha medicines. With these special properties of Kaantham, it could be very effective in treatment of various diseases.

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Application of First Zagreb Index to Periodic Table Elements

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ABSTRACT

The applications of graph theory, more specifically topological indices are well known tools, grabbing the attention of researchers working in the field of chemical graph theory. In this paper we have provided a study on very close relationship between the degree based topological index, Zagreb index and physio-chemical property of the elements of periodic table. Hence obtained a new approach to study this molecular descriptor to analyze QSPR and QSAR property of the elements of periodic table.

Keywords: Degree; dipole graphs; periodic table; atomic weight; molecular graph.

INTRODUCTION

In the recent graph theoretic world, it has become very customary for one to come out with a new finding related to the application of graph theory to the modern world. These findings can either be related to the technological aspects or they may be related to life sciences. To define formally, Graph theory is nothing but the approach to study a collection of subjects involved in a problem under the name node set or vertex set $V(G)$ and the constraints that connect them drawn with lines named as edge set $E(G)$. The idea of doing so is to obtain a skeletal structure to the given problem and therefore making it easy to study the degree of involvement of all the variables and constants along with their property that indeed help to obtain the solution to the problem. This idea was put forward first by Leonhard Euler in 1736, where he published his paper on the solution of problem on Seven bridges of Königsberg[3]. In the chemical graph theoretic field, the molecular structure of a compound is often drawn as a graph in which atoms are marked as vertices and bonds between each of them are drawn as edges, where double bonds are neglected and considered to be single edge for simplicity. This method of applying chemical compounds to graph theoretical models was first laid forward by prominent researchers of chemical theory Alexandro Balaban [2]. In 1805 John Dalton defined that "All matter was composed of small particles named





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as atoms". He pictured the atom as a dense solid individual tiny particle which is unable to subdivide. At the end of the 19th century there are many experiments which reveals that the atom is constructed by still smaller particles known as subatomic particles which are also called as the fundamental particles. The three most chief fundamental particles are the proton, neutron and electron. The study of pattern of allotment of these three particles to frame the internal atomic structure is very interesting. Atomic structures also well known as Bohr's atomic structures. The Rutherford found that electrons were revolving around the nucleus. However, Rutherford model did not tell anything about the position of the electrons and how they were aligned around the nucleus. The Classical laws states that, an electron which is in motion in a field of nuclear force, would emit radiations and gradually faint into the nucleus. Thus, Rutherford model failed to convey the way electrons did not do so. Later, a brilliant Danish Physicist, Niels Bohr, mentioned that, "the old physics laws just did not work out in the submicroscopic world of the atom". He intimately worked and studied on the electron's behavior, radiations, and atomic spectra. In 1913 Bohr introduced a new atomic model based on modern Quantum theory of energy. With his model he explained that why a revolving electron did not faint into the nucleus [1]. Bohr's electronic shells or levels, designated as Quantum Numbers 'n'. This quantum number denotes the principal shell to which the electron belongs. The alphabetical characters K, L, M, N, O, P, and Q are also utilized to represent the energy levels or shells of electrons with a *n* value 1, 2, 3, 4, 5, 6, 7 respectively. There is a limited number of electrons in an atom which can have the same principal quantum number and is given by $2n^2$, where *n* is the principal quantum number concerned. Thus, In 2016 it was reported that the periodic table has 118 confirmed elements from hydrogen (atomic number=1) to Oganesson (atomic number=118).

Principal quantum number <i>n</i> =	1	2	3	4
Letter designation	K	L	M	N
Maximum number of electrons $2n^2$ =	2	8	18	32

MATERIALS AND METHODS

It's a very basic and important factor for any element to be guided by its atomic weight. Atomic weight also known as atomic mass, is the average mass of atoms of an element, calculated using the relative abundance of isotopes in a naturally occurring element. An atomic weight is indicated by its atomic mass. Technically, the size of an atom is the sum of its protons, neutrons, and electrons size. Since an electron's mass is so much smaller than that of other particles, its mass is equal to that of the nucleus, which consists of protons and neutrons. To determine the total number of protons and neutrons in a pure isotope's atomic nucleus, round the atomic weight to the closest integer. It can also be termed as relative weight of the atom on the basis of oxygen determined as 16.

In this work we have made an attempt to deduce some of the major relationships between the atomic weights of the first 40 elements of the periodic table and their structural characteristics. The development of degree-based topological indices has been a boon to the study of chemical graph theory. The nature of the positioning of electrons on each shell of the atomic structure of the relevant element will be depicted here based on the key degree-based topological index known as the first Zagreb index. The first Zagreb index [5] in graph theory is defined as follows:

$$M_1(G) = \sum_{v_i \in V(G)} d_i^2$$

The use of topological indices to the fields of physiochemical and biological sciences is a widespread method. Several scientific tests have shown that the structure of chemical entities can be linked to their biological and molecular activity. These tools help in analyzing and exploring the (QSAR) and (QSPR) properties of molecular structure. Nowadays, many young researchers have led their concentration on defining new molecular descriptor and producing their applications to the other fields of sciences. The recent work on defining the new molecular descriptor known as status connectivity index and application of it to find the boiling point of hydrocarbons [4] inspired us to formulate a new formula for analyzing the atomic weight of the first 40-elements of periodic table with the aid of predefined first Zagreb index.





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RESULTS AND DISCUSSION

According to definition we observe that the first Zagreb index is computed on the basis of degree of each vertex involved in the given graph. Degree of the graph is defined as the number of vertices that are adjacent to the particular vertex under consideration. Studies on the nature of definition of atomic weight inspired us to arrive at the idea of analyzing the same with the help of degrees of the electrons situated on each shell of the periodic elements. The atomic structure of the elements can be referred to as molecular graph which consist of more than one component. The components studied here are the shells of the atomic structure. Among these components we can observe that there is one multi graph shell whose nature admits the properties of dipole graph with two multiple edges between any two vertices. It's important to note that degree of vertex of the dipole graphs $D_{r,s}$ having two vertices joined by r parallel edges and s loops is substituted using the formula $d = r + s$. Since there are no loops for any dipole graph the quantity s will be substituted to be zero. Except for hydrogen having single shell with single vertex/electron having self-loop, degree of this electron /vertex will be 2. After considering all of these essential parameters, we predict a formula to determine the approximate weight of an atom. This approximate weight of an atom was computed using the following formula:

$$\text{Approx. AtomicWeight} = \frac{M_1(G)}{2}$$

Despite the seemingly straightforward method, it becomes very essential for one to understand the importance of molecular structure in analyzing its own chemical /physical properties without actually conducting any experiment and still being able to depict the mere point of correlation based on structural observation made on the grounds of degree of each electron present on those shells of particular elements. It was observed that there is a strong correlation between the atomic weight and the fraction of degree based topological index being first Zagreb indices. The Table I gives the clear picture of all the 40 elements from the periodic table their first Zagreb index formulated approximate atomic weight (Approx. A.W.) and actual atomic weight (A.W.).

CORRELATION

It's always a mandatory procedure to clearly justify the claims shown in the work with proper proof of ideology carried out as to on what basis the studies were done. Therefore, we have made a systematic approach to correlate our idea of defining approximated atomic weight of those elements shown in Table I and their actual atomic weights. The correlation between the actual atomic weight and the atomic weight computed using first Zagreb index is shown in the below Table II. It is evidential from the above Table II, that the correlation between the actual atomic weight and approximated atomic weight is 0.998061. this result is most accurate as of now and hence we can also justify that since the distance based topological index, the first status connectivity index is also related to Zagreb index there will be obviously a good correlation between these physical structure studies too. It's very evidential that the correlation between both actual atomic weight and approximated atomic weight is 0.998061, which is quite a good value. From this idea it can be clearly depicted that since the distance-based connectivity index, first status connectivity index can be derived using first Zagreb index, it's possible to find a good correlation between the actual atomic weight and approximated atomic weight formulated using distance of electrons instead of degree.

CONCLUSION

The above studies are clearly based on representing each element of the periodic table into its physical structure and later on applying the graph theoretical fundamentals to understand the QSAR/ QSPR studies of these structures based on the position of electrons with relation to the molecular descriptor, Zagreb index. One can further try to find new way of considering the physical structure of these elements and analyze the relation with any other molecular descriptor.




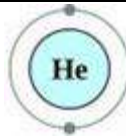
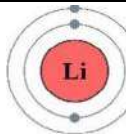
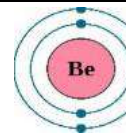
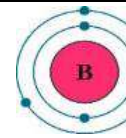
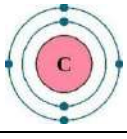
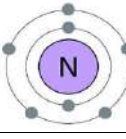
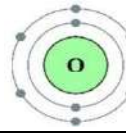
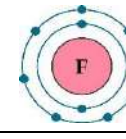
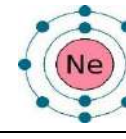
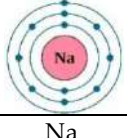
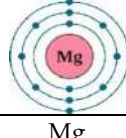
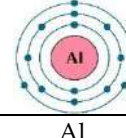
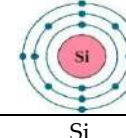
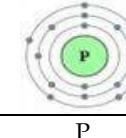
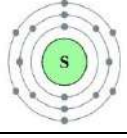
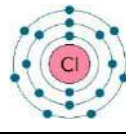
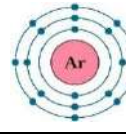
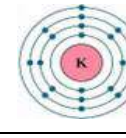
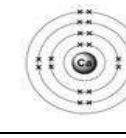
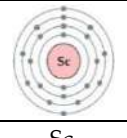
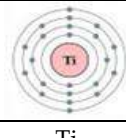
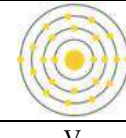
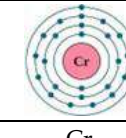
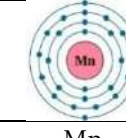


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Table 1: actual atomic weight and approximated atomic weight of periodic table's first 40 elements

At. Str.					
Element Atm. Wt. Approx. At. Wt.	H 1.00800 2	He 4.002602 4	Li 6.94000 6	Be 9.0000 8	B 10.8100 10
At. Str.					
Element Atm. Wt. Approx. At. Wt.	C 12.011 12	N 14.007 14	O 15.99 16	F 18.998 18	Ne 20.17 20
At. Str.					
Element Atm. Wt. Approx. At. Wt.	Na 22.98976 22	Mg 24.305 24	Al 26.98153 26	Si 28.085 28	P 30.97376 30
At. Str.					
Element Atm. Wt. Approx. At. Wt.	S 32.06 32	Cl 35.45 34	Ar 39.948 36	K 39.0983 38	Ca 40.078 40
At. Str.					
Element Atm. Wt. Approx. At. Wt.	Sc 44.9559 42	Ti 47.867 44	V 50.9415 46	Cr 51.9961 48	Mn 54.9380 50





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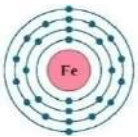
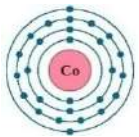
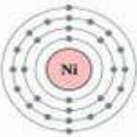

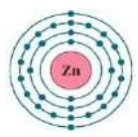
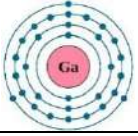
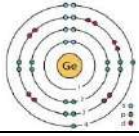

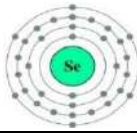
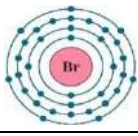
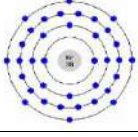
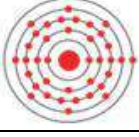
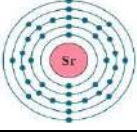
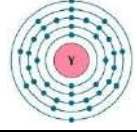
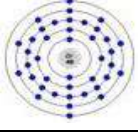
At. Str.					
Element	Fe	Co	Ni	Cu	Zn
Atm. Wt.	55.845	58.933194	58.6934	63.546	65.38
Approx. At. Wt.	52	54	56	58	60
At. Str.					
Element	Ga	Ge	As	Se	Br
Atm. Wt.	69.723	72.63	74.921595	78.971	79.904
Approx. At. Wt.	62	64	66	68	70
At. Str.					
Element	Kr	Rb	Sr	Y	Zr
Atm. Wt.	83.798	85.4678	87.62	88.90585	91.224
Approx. At. Wt.	72	74	76	78	80

Table 2: Correlation coefficients of the estimation

	Sl. No	Atomic number	Zagreb	Approximate atomic weight $\frac{M_1(G)}{2}$	Atomic weight
Sl. No	1.000000	1.000000	1.000000	1.000000	0.998061
Atomic number	1.000000	1.000000	1.000000	1.000000	0.998061
Zagreb	1.000000	1.000000	1.000000	1.000000	0.998061
Approximate atomic weight $\frac{M_1(G)}{2}$	1.000000	1.000000	1.000000	1.000000	0.998061
Atomic weight	0.998061	0.998061	0.998061	0.998061	1.000000





Lactic Acid Bacteria As a Probiotics and Source of An Essential Enzyme Phytase

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ABSTRACT

Lactic Acid Bacteria (LAB) are beneficial, safe, bile, and acid tolerant and have the ability to colonize and adhere in the intestinal tract. It is present in a variety of fermented food provides many health benefits and can be used as probiotics. Probiotics possess a number of many beneficial effects on animals and human health. They also strengthen the immune system by providing protection to the host against many harmful microorganisms. Some group of probiotics are also known to reduce many metabolic disorders and helps in improving feed digestibility of phytate in animals and reducing phosphorus pollution in the environment. Phytase belongs to the phosphatase class of enzymes that catalyzes the sequential hydrolysis of phytic acid (an indigestible, organic form of phosphorus) to less phosphorylated myoinositol derivatives, resulting in the release of inorganic phosphate. Phytate is an antinutrient element as it has six reactive phosphate groups making it a chelating agent, and forms complexes with divalent cations like Ca, Fe, Zn, etc. The enzyme phytase plays an important role in manufacturing and processing of food for human consumption. Monogastric animals lack phytase enzymes, due to which they cannot utilize dietary phytate, therefore excessive phosphorus accumulation occurs in their excreta which increases phytate content in soil and water thus leading to an environmental concern. For solving such problems, supplementing diets with phytase as a feed additive is getting attention in the food and feed industry. In the present review, we focused on different sources of probiotics and phytase-producing microorganisms.

Keywords: Lactic acid bacteria, Probiotics, Phytate, Phytase





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INTRODUCTION

By 2022, the need of functional food due to increased nutritional and health issues, is expected to touch the mark of 96 billion USD [1] and probiotics could be the possible solution to serve in functional food as they raise the nutritional value other than only increasing organoleptic properties. Lactic acid bacteria as probiotics produce enzyme phytase in the gut which have nutritional and therapeutic values associated with them. Human food with phytase tend to enhance the bioavailability of important divalent mineral ions which release myo-inositols and can be used as therapeutic measure for many diseases like Alzheimer's disease, Irritable Bowel Syndrome and Crohn's disease. Phytase (myo-inositol hexakis phosphate phosphohydrolases) hydrolyses the phosphoric monoester bonds in phytic acid, a major component of phosphorous in plant diets and has strong chelation with divalent minerals such as Ca^{2+} , Mg^{2+} , Zn^{2+} and Fe^{2+} . Nowadays, population explosion and global industrialization due to environmental causes lead to a focus on various new methods of enzyme processing and optimization which leads to escalating interest in enzymes [2]. LAB is among one of the important classes of bacteria that produce one of the important enzymes which is Phytase. In today's world, the meaning of food is not to full fill hunger but to provide all essential nutrients to humans as well as to cope with nutrition-related diseases and to improve the health of the consumers.[3] Some staple food e.g. cereal and legumes are rich sources of phosphorus but are found in the form of phytic acid. Phytic acid chelates with many divalent cations e.g. calcium, zinc, magnesium, etc. Phytic acid is also known as myo-inositol hexakis phosphoric acid or myo-inositol-1, 2, 3, 4, 5, 6 hexakisdi hydrogen phosphate scientifically.[4] To fulfill the nutritional requirement of consumers for phosphorus, there is a need to release phytate-bound phosphorus, for this phytate degrading enzymes are needed, and probiotics could be a possible solution other than providing many other beneficial effects joined with them. An increase in consumer demand gaining interest in obtaining extra benefits associated with food has energized functional foods to make an appearance in the market, for which Japan, Europe, and USA have resulted in dominating markets [5]. Functional foods, probiotics, e.g. cereals, and beverages with vitamins, claim to provide many essential health benefits associated with them other than their nutritional value. Foods that contain live bacteria known as probiotics tend to increase both nutritional and health benefits to humans.

LACTIC ACID BACTERIA

The term Lactic Acid Bacteria (LAB) was first time accepted in commencing of the 20th century. The common occurrence of lactic acid (LA) bacteria in foods along with their capacity for long-term uses and contribute to their natural acceptance as GRAS (Generally Recognized as Safe) for human consumption [6]. Lactic acid bacteria (LAB) may be defined as Gram-positive with low-GC content and have acid tolerant capacity. They are generally rod or cocci-shaped and have common physiological and metabolic characteristics. They are commonly named lactic acid bacteria because they are found in dairy products and decomposing plants and produce lactic acid as an end during carbohydrate fermentation. Bacteria are mostly grouped into cocci and rod on their basis of shape and they have also grouped into homo fermentative LAB and hetero fermentive lactic acid bacteria based on end product. Homofermentative lactic acid (LA) bacteria are those which produce mainly lactic acid (LA) from sugars as an end product whereas heterofermentative lactic acid (LA) bacteria are those which produce a considerable amount of acetic acid with alcohol with add on to lactic acid (LA). Lactic acid bacteria (LAB) are generally found in natural environments where carbohydrates are found in soluble form, with protein products in breakdown form, and where low oxygen was found.

LACTIC ACID BACTERIA AS PROBIOTICS

Lactic acid bacteria a major group of probiotics had come into existence since the time of Hippocrates who stated that "Let food be thy medicine and medicine be thy food". The word 'probiotic' consists of two words, pro, and bios which mean for life. Probiotics are live microorganisms when taken in adequate amounts, provide many health benefits to the host.[7] LA bacteria, a major group of probiotics, provide many health benefits and are regarded as GRAS (Generally Recognized as Safe) for industrial purposes[6]. Many food items supplemented with probiotics are





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known for treating disorders and improving the health of the gut through the use of biotherapies and now gaining popularity. Many dairy products and fermented milk are known for many bioactive compounds and novel probiotics which preserve microflora for years. In lactose intolerant individuals, yogurt from yogurt bacteria such as *Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus thermophiles* are known to improve the digestion of lactose and are approved by European Food Safety Authority (EFSA Panel on Dietetic Products and Allergies, 2010) Mostly, probiotics enhance the fraction of many human diseases, for eg, diarrhea, hypertension, cancer, lactose intolerance, skin problems, allergies, and many more.[10] In general, lactic acid bacteria are known for their therapeutic nature and for raising resistance to many infectious diseases in cancer suppression, lactose maldigestion, GIT, and dermatological problems.[9] It is well known that probiotics also reversed some human diseases linked with the imbalance of the intestinal ecosystem.[11] A potential list of probiotic microorganism which has therapeutic properties is given in Table 1.

PHYTATE; AN ISSUE RELATED TO IT

Phytic acid (myo-inositol hexakisphosphate, IP6) or phytate, a main constituent of many plant seeds is a phosphorylated derivative of myo-inositol. It constitutes approximately 1 to 3% by weight of oil seeds and many cereals which accounts for 60-90% of total phosphorus in plant.[26] Phytic acid chelates with many divalent cations e.g. calcium, zinc, magnesium, etc. Phytic acid is also known as myo-inositol hexakis phosphoric acid or myo-inositol-1, 2, 3, 4, 5, 6 hexakis (dihydrogen phosphate) scientifically.[4] The phytate presence in diet and its complex-making power with divalent ions shows a negative impact on mineral absorption as well as on dietary proteins.[27] fig 2

PHYTIC ACID: ENVIRONMENTAL CONCERN

Inorganic phosphorus (Pi) is required by plants for their growth and they are consumed in the form of phytate through roots, tissues, or seeds. Phytate needs to be hydrolyzed to release inorganic phosphorus in soil and to complete the phosphorus cycle in nature. Animal feeds need to be supplemented with inorganic phosphorus to fulfill the phosphorus requirement. Further, diets based on plants, when consumed by monogastric animals, cannot hydrolyze phytate, which leads to a high discharge of phytic acid in the environment and results in environmental pollution. Eventually, much phytate content is washed away in water bodies and is degraded by aquatic microbes releasing Pi. Fig 3 And it results in eutrophication which is characterized by unbalanced algae growth, and depleted dissolved oxygen content, leading to anaerobic environments for aquatic animals and consequently, life threats to waterborne aerobic organisms [29] and in addition to this many common problems related to odor and taste.[30]

CLASSIFICATION OF PHYTATE DEGRADING ENZYMES

Phytases [myo-inositol (1, 2, 3, 4, 5, 6) hexakisphosphatephosphohydrolases] are a group of phosphatases that carry out the hydrolysis in a sequential manner of phosphate ester bonds of phytate to less phosphorylated myo-inositol and pi (inorganic phosphate derivatives). The activity of phytase was first time found in rice bran.[31] It was also reported in calf liver and blood in 1908.[32] Depending upon the basis of characteristics, enzyme phytase had been divided into different groups:

DEPENDING UPON THE INITIATION SITE OF PHYTATE DEPHOSPHORYLATION AT DIFFERENT POSITIONS OF THE INOSITOL RING

According to the nomenclature given by IUPAC-IUBMB (International Union of Pure and Applied Chemistry & International Union of Biochemistry and Molecular Biology), the enzyme phytase has been divided into different groups:

- a) 3-phytase, EC 3.1.3.8 (myo-inositol hexakis phosphate-3- phosphohydrolase) which results in yielding 1, 2, 4, 5, 6-pentakisphosphate and inorganic phosphate upon hydrolysis.
- b) 5-phytase, EC 3.1.3.72, (myo-inositol hexakis phosphate-5- phosphohydrolase) which produces 1, 2, 3, 4, 6-pentakisphosphate and inorganic phosphate upon hydrolysis.





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- c) 6-phytase, EC 3.1.3.26, (myo-inositol hexakis phosphate-6- phosphohydrolase) which yields 1, 2, 3, 4, 5-pentakisphosphate and Pi upon hydrolysis (Nomenclature, 1979).

Microbial phytases, especially those of fungal origin (E.C. 3.1.3.8), often split the phosphate group at the C1 or C3 (carbon) of inositol ring (D-and L-configuration), and are called 3-phytases and is found in microorganisms. Plant phytases (E.C. 3.1.3.26) act preferentially at the C6 carbon, and are called 6-phytase and are characteristic of seeds in higher plants.[34]

DEPENDING UPON THE OPTIMUM PH OF ACTIVITY

Phytases can be categorized as an acidic, neutral, or alkaline group of phosphatases based on optimum pH activity. The optimal activity at pH 5.0, 7.0, and 8.0 respectively was documented for these groups.[35,36]

DEPENDING UPON STRUCTURAL AND CATALYTIC PROPERTIES

Phytases are classified into four classes i.e., (a) Purple acid phosphatase (PAPhy), (b) Histidine acid phosphatases (HAPhy), (c) β -propeller phytases (BPPhy), and (d) Cysteine phytases or protein tyrosine phytase (PTPhy).[33,36]

a) Purple Acid Phosphatases (PAP)

These groups of enzymes contain two metal ions bound to the central nuclear core, one generally is Fe³⁺ and the other may be Fe²⁺, Zn²⁺, or Mn²⁺.

b) Histidine Acid Phosphatases (HAP)

They have been isolated both from prokaryotes and eukaryotes. High molecular weight HAPs possess characteristic N-terminal RHGX₂RP motif and C-terminal HD motif which renders a two-step mechanism for the hydrolysis of phosphate monoesters[37,38] while low molecular weight HAP lacks both N- and C-terminal motifs.

c) β -propeller Phytases (BPP)

Previously, they are restricted to bacillus species, now they are widely distributed in nature. Depending upon structure, cofactor dependence, nucleotide sequence, and mode of action differentiate BPPs from many other phytases.[37] The arrangement structure of BPPs suggests different modes for the hydrolysis of phytates.[39]

d) Cysteine Phosphatases (CP)

CPs or protein tyrosine phosphatase-like phytases (PTPLPs) are the least common class among other classes of phytase that show structural folding patterns and the catalytic mechanism similar to that of protein tyrosine phosphatases (PTP). Structurally, Cysteine phosphatase, CPs consist of a large domain of a 4-stranded β -sheet and a small domain of a 5-stranded β -sheet. A large domain is surrounded by numerous α -helices on both sides and has a large and deeper pocket of the catalytic site. Substrate specificity is determined by the depth of this catalytic pocket.[40]

SOURCES OF PHYTASES

Phytases are mostly widespread among various forms of life which include plants, bacteria, fungi, certain animal tissues and yeast.[41]table 2

APPLICATIONS OF PHYTASES

Since enzyme phytase possesses the ability to carry out sequential hydrolysis of phytate complexed with biomolecules and minerals, it has possessed various multifaceted applications. In particular, microbial phytases, are dominant enzymes for the food and feed industry with many other biotechnological applications. Fig 4

ANIMAL FEED SUPPLEMENT

Plant sources such as cereals, soya beans, and legumes are major formulations for animal feed and are rich in phytate content.[62] Monogastric animals like swine, poultry, humans and fish may have very less or negligible amount of phytase in the gastrointestinal tract, thus not able to utilize dietary phytate. Therefore, animal feed supplemented with external phytase is necessary for degrading phytate and ultimately enhancing the bioavailability of minerals. In



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this way, additional phosphorus load minimizes in feed and environmental phosphorus pollution is controlled.[63] 50% of phosphorus excretion is reported when animal feed contains or is supplemented with external phytase.[64]

FOOD INDUSTRY

The application of enzyme phytase mainly relies upon technical improvements for food processing and enhancing the bioabsorption of minerals by the process of dephytinization. Much metal deficiency disease can be prevented by supplementing phytase in plant-based foods to carry out the dephytinization of phytates bound with metals. Alkaline phytase isolated from *Bacillus amyloliquefaciens* DS11 results in enhancing mineral availability and reduced content of phytate in wheat bread.[65] Microbiological shelf life and physical properties such as volume, quality, and texture of wheat bread can be improved by the use of enzyme phytase as reported.[66,67] Phytase produced from LAB Generally Regarding as Safe (GRAS) microorganisms are approved by FDA for practical applications.

IN AGRICULTURE: AS PLANT GROWTH PROMOTERS

For plant growth, phosphorus is considered as one of the essential macronutrients. Phosphorus in organic form as phytate is found in soil and contributes 10-50% of total pi (inorganic phosphorus) and results in forming complex with cations. These complexes are not absorbed by plants completely.[68] The phosphorus cycle can be completed by releasing inorganic phosphorus (Pi) from phytates with the help of microbial phytases.[69] Rhizobacterial species e.g. *Klebsiella*, *Citrobacter*, and *Enterobacter* releases a good amount of phytases and have been found in enhancing the shoot-to-root ratio in pigeon pea.[70]

COMBATING ENVIRONMENTAL PHOSPHORUS POLLUTION

Animals such as monogastric are unable to carry out the degradation of phytate in their digestive tract due to which they produce a significant amount of phytate in their waste and which is ultimately degraded by microbes present in soil. Due to this, phosphorus ultimately reaches water bodies after the degradation process and causes eutrophication which reduces the content of dissolved oxygen in water bodies due to which aquatic fauna will ultimately lead to death. Therefore, it is necessary to pretreat animal feed with enzyme phytase, leading to the bioavailability of Pi inorganic phosphate in the environment which results in improving quality of animal feed and reduction in environmental phosphorus pollution.[66,68] *E.coli* bacteria are well known for producing enzyme phytases that help in reducing phosphorus in transgenic mice, and pigs and thus reducing environmental pollution.[71]

E) PULP AND PAPER INDUSTRY

The aging of paper is one of the major problems faced by paper and pulp industries. Phytate removal may be helpful in these industries. A thermo-stable phytase has the potential to act as a biological agent for decomposing phytate in paper and pulp industries at the processing stage.[72]

CONCLUSION

Phosphorus in the form of phytate found in many plant-based feeds is not readily available to poultry and animals. Phytate is not utilized by animals and poultry birds due to a lack of phytase enzyme and is excreted directly into the environment as a waste product, so there is a need of supplementing inorganic phosphorus to overcome the phosphorus deficiency. The enzyme phytase or use of non-pathogenic phytic acid degrading microorganisms might be useful for artificial supplementation with the feed of animals. In human diets, especially in the case of lactating or expecting women, increased level of divalent cations such as calcium, iron, and zinc was reported, so there is a need for phytate-degrading microorganisms in consumable forms like probiotics. Raw foods fermented with probiotic bacteria such as lactic acid bacteria are supposed to enhance the valuable quality of the supplemented feed.





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Table 1. Potential List of Probiotic Microorganisms.

Probiotic microorganisms	Human disease	References
<i>L. GG, L. rhamnosus GG</i>	Allergies	[12,13]
<i>L. casei, L. plantarum, L. paracasei, Lc. lactis, Ent. faecium</i>	Hypercholesterolemia	[14-17]
<i>L. acidophilus</i> NCFM, <i>L. gasseri</i> SBT2055, <i>L. rhamnosus</i> CGMCC1.3724	Diabetes and obesity	[18-20]
<i>L. rhamnosus, L. rhamnosus GG, Bif. lactis</i> alone or in combination with <i>Strep. thermophilus</i> , and <i>L. reuteri, L. rhamnosus, L. acidophilus, L. casei</i>	Acute and antibiotic associated diarrhea	[21]
<i>Bif. lactis, L. acidophilus, L. casei, L. plantarum, Sac. cerevisiae</i>	Irritable bowel disease	[22,23]
<i>L. acidophilus, L. crispatus, L. gasseri, L. reuteri, L. rhamnosus, L. vaginalis, Strep. thermophilus</i>	GIT and urogenital tract infections	[24,25]

L.: *Lactobacillus*; Lc.: *Lactococcus*; Leu.: *Leuconostoc*; Ent.: *Enterococcus*; B.: *Bacillus*; Bif.: *Bifidobacterium*; Sac.: *Saccharomyces*; Strep.: *Streptococcus*.

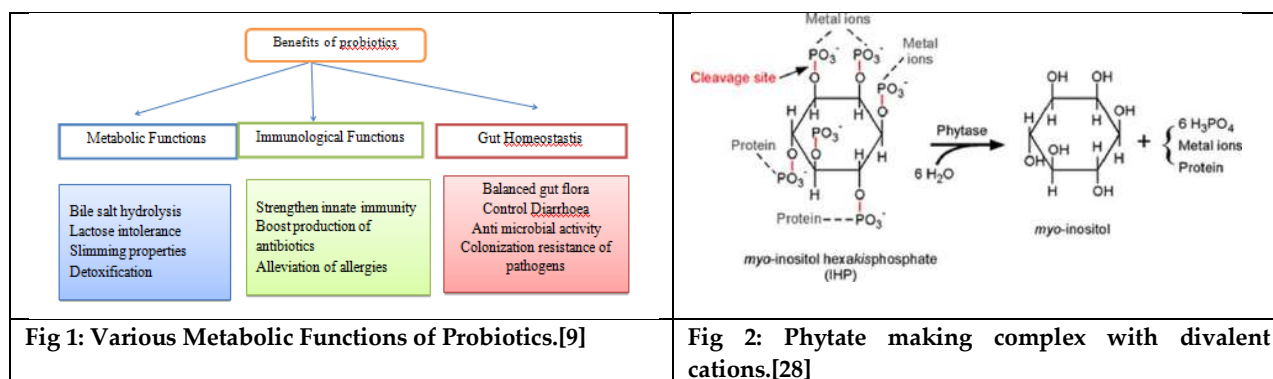




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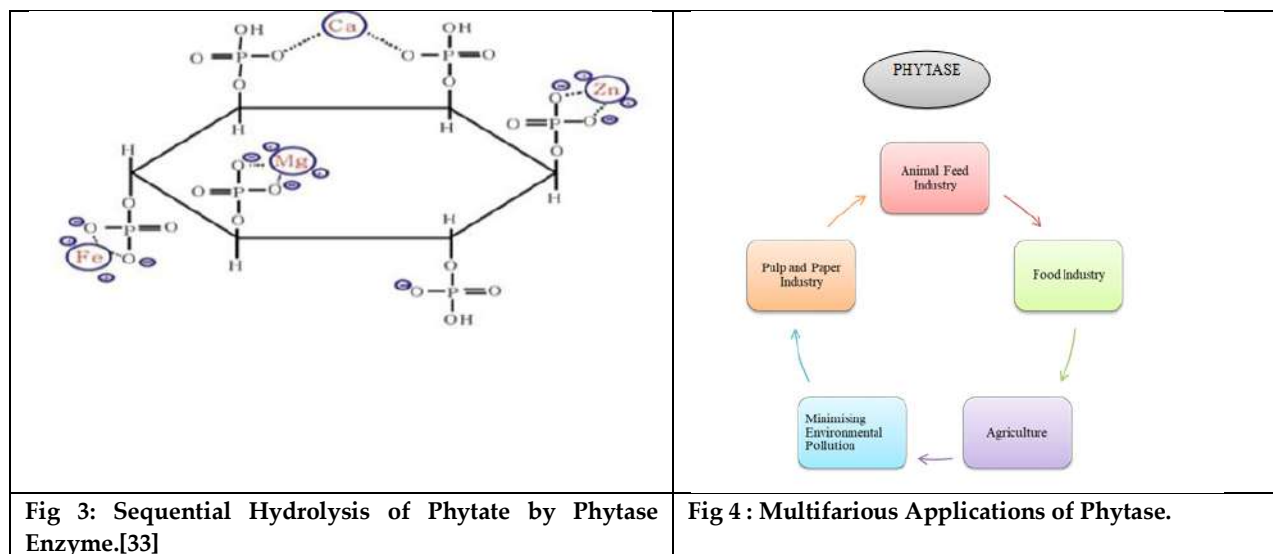
Table 2: Different Sources of Enzyme Phytase

S.No	Sources of Phytase	Species	Functions	References
1.	Plant	Maize (<i>Zea mays</i>), Wheat (<i>Triticum aestivum</i>), Rice (<i>Oryza sativa</i>), Rye (<i>Secale cereale</i>), Barley (<i>Hordeum vulgare</i>), Oats (<i>Avena sativa</i>), Sorghum (<i>Sorghum sudanensis</i>) and Millet (<i>Pennisetum typhoides</i>)	Cause phytin degradation	[42-44]
2.	Animal	Calf liver, reptiles, fishes, birds, sea turtle, chicken, rat, calf, human intestines	Reduce phytate content	[45,46]
3.	Bacteria	<i>Citrobacter braakii</i> , <i>Klebsiella</i> sp., <i>Enterobacter</i> , <i>Bacillus</i>	Increased efficiency, applicability, commercial and economic value	[47-51]
4.	Fungi	<i>Rhizoctonia</i> sp., <i>Fusarium verticillioides</i> , <i>Mucor indicus</i> , <i>Aspergillus terreus</i> , <i>Rhizopus oryzae</i> and <i>Aspergillus flavus</i> ITCC 6720	Good source of extracellular phytase	[52-56]
5.	Yeast	<i>Schwanniomyces castellii</i> , <i>Schwanniomyces occidentalis</i> , <i>Arxula adeninivorans</i> , <i>Rhodotorula gracilis</i> , <i>Hansenula polymorpha</i>	Enhanced mineral bioavailability, good source to use as a feed supplement in aquaculture.	[57-59]
6.	Microbial	<i>Pedobacter nyackensis</i> and <i>Erwinia carotovora</i>	Stable at low temperature used in aqua feed.	[60]
7.	Probiotics	<i>B. subtilis</i> , <i>Bacillus cereus</i> , and <i>Pseudomonas aeruginosa</i>	Improve quality of feed and combat mineral deficiency.	[61]





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Automated Plant Disease Detection Framework using Deep learning

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ABSTRACT

Plant disease has the potential to significantly reduce food supply while also eradicating species variety. Early identification of crop diseases using precise or automated detection techniques can improve food production while minimizing economic losses. Deep learning has significantly improved the identification accuracy of image categorization and object detection systems in recent years. As a result, in this article, a pre-trained convolutional neural network (CNN) model is used for fast plant disease diagnosis. The proposed model concentrated on improving the hyper parameters of popular pre-trained models as Mobile Net, ResNet-152, VGG-19, and Inception v3. On the real-time banana leaves capture dataset, the proposed model employs ResNet152 architecture and complicated hidden layers fine-tuned with Random search tuning techniques. The performance of the proposed model was evaluated utilizing classification accuracy, precision, recall, and F1 score. A comparison with other cutting-edge studies was also performed. From the results it was observed that ResNet152 outperformed state-of-the-art models in classification accuracy by 98.3% in trials.

Keywords: Plant disease, deep learning, CNN, ResNet152, Banana Leaves

INTRODUCTION

Agricultural production, as a significant player in the global business, is the main source of food, revenue, and jobs. Agriculture contributes 18% of India's revenue and 53% of jobs, as it does in other low- and middle-income countries with a big farmer population. This industry contributes the most to economic growth. As a result, the effect of plant illness and pest infections on agricultural may have an influence on the global economy by lowering food production



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quality. Agriculture is regarded as the primary source of revenue in the majority of developing countries. Because bananas are high in minerals such as calcium, iron, and so on, banana cultivation is a significant area of global agrobusiness. Because this crop has so many nutrients, it is taken by individuals from all over the world because bananas are regarded an immediate energy booster. According to Wikipedia, around 15% of global banana output is exported to western countries for consumption. According to banana production and export estimates, India accounts for around 25.7% of worldwide banana output, with the Philippines, Indonesia, and Brazil contributing for approximately 20%. The impact of a banana tree becoming infected owing to disease or other climatic changes will result in a loss of up to 100% of the country's banana output and export. Bananas are generally afflicted by five primary diseases such as Banana black Sigatoka, Banana yellow Sigatoka, banana Healthy, Banana Panama wilt and Banana leaf spot with dimensions of 256×256 . Sample images from the dataset are shown in Figure 1.

LITERATURE SURVEY

The authors of [1] described a Corn leaf function optimal control framework for improving maize qualities in a complex setting. Robust Alex net was employed during this research for precise extracting features. Increased usability and accuracy are among the benefits. The job lacks real-time diagnostics and difficulty assessment. The researchers were suggested by [2] sensing difficulties in rice images such as noise, blurring picture edges, low high detection, and higher noise interference. The results showed that precision had increased while time complexity had decreased. One limitation was that the identification of illness and dynamic scanners of huge paddy cultivation was not carried out. The researchers of [3] presented an illness detection approach that is web-enabled designed for effective disease detection via compressed sensing. The research proposal was endorsed by the researchers to use both modelling as well as novel analyses for something like a wide range of plants. SVM was used for categorization, yielding an overall accuracy of 98.5. A classification algorithm that is dependent on an evolutionary algorithms and a support vector machine was proposed by the researchers of [4]. A findings indicate that the proposed task has a detection accuracy of 95.71% and a classification accuracy of 97.6%. For farmer convenience, the author proposed [5] an efficient plant strain detection mechanism that is automated.

The author developed a web-based tool to identify pomegranate diseases based on colour and morphology. With an accuracy of 82%, the K-Means method is used for classification and segmentation using SVM. A framework uses a camera to capture images of the leaves in the field, as well as device having to learn to categorize the leaf as good health or unhealthful. This article [6] concentrated on leaf crop diseases. Author created a method to identify plant illnesses in fresh leaves using transfer learning methods like deep learning, using CNN as a trait representation and SVM as a classification engine. This paper [7] focuses on developing quite a scheme for smart agriculture, specifically initial detection of illnesses in leaf tissue, and provides farm owners with solutions. The primary contributors are the innovative pixel replacement fragmentation and the double trying to extract characteristics methods for improving classification. This paper [8] illustrates the effectiveness of the structure by evaluating variables such as memory space, safety handling overhead, in live time using a WMSN testbed. A purpose of this research [9] is to inform farmers about cutting-edge innovations for reducing plant leaf illnesses. Because tomato is a common vegetable, methods utilizing machine learning and image analysis with a precise automated system have been recognized for identifying crop disease in tomato plants. The suggested system [10] processes leaf images and extracts texture information using imaging techniques and IoT. Located somewhere at station, the GLCM features are classified using the RFC method and analyzed by agriculture experts who provide solutions. The author [11] proposed technique demonstrates an automated method for agricultural diagnostic testing that use for feature extraction and Classifier to categorize varied leaf sample images from various crop kinds. When employing the proposed technique, every crop health phase uses its own One Description. The grape leaf-trained systems demonstrated flawless generalization when tested in other crops. Whenever ambiguous test data can belong with one or more criteria, a novel technique based on resolving conflict among Each Systems – determines the correct state.



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METHODOLOGY

For object recognition and classification, CNN models function well with image databases. Despite the benefits of CNNs, there are still challenges, such as the lengthy training period and the requirement for massive datasets. Deep CNN models are required to extract low-level and intricate properties from images, which makes model training more challenging. Transfer learning strategies can address the concerns stated previously. Transfer learning makes use of pre-trained networks to apply parameters of the model learned on one data to another. In image-based research, deep-learning algorithms are commonly employed. They are particularly good at extracting low-level, complex properties from images. Deep CNN layers, on the other hand, are challenging to train because of the computational expense of the method. To overcome such issues, the suggested model was built by transferring learning-based methodologies. These models are trained using the Capture dataset, which has many classifications. Because visual characteristics like corners and shapes are ubiquitous across data, such algorithms may be trained with real time capture image. As a result, the transfer learning strategy was discovered as being the most appropriate and robust model for picture categorization. Our selected color photographs from the real-time collected dataset for our experiments since they matched well with the transfer learning models. Because we employed several pre-trained network models that need varied input sizes, the photos were downsampled to $n \times n$ pixels as a consistent format. Plant disease files provide images of sick and healthy selected plants, with each sample classified.

If we consider the banana plant to be a class, all photos of healthy and sick plant samples will be assigned to that class. The target picture has been categorized purely on the basis of the input images properties. Implementation is based on banana datasets that include Banana healthy, Banana panama wilt, Banana leaf spot, Banana Yellow sigatoka, and Banana Black sigatoka illness. We divided the dataset into training, testing, and validation samples for our experimental study. 80% of the capture dataset was utilized to train the pre-trained models, with the remaining 20% used for validation and testing. All of these train, test, and validation sets contain four different banana plant diseases. After training using sets of disease samples from various plant classes, a specimen of a single disease is retrieved as input, and the testing phase output will classify the illness's precise label from among the four categories mapped under that specific class. Multi-class classification is therefore mutually exclusive, whereas multi-label classification considers each category inside a class to be a different class. Transfer learning allows for more accurate tasks since the model may be taught by freezing the final or earliest layers. The model parameters may thus be kept and modified for feature extraction and classification by freezing the layers. In this work, the performance of several transfer learning models are compared with deep CNNs in order to improve recognition and classification accuracy while reducing time complexity. Figure 2 depicts our process architecture. The real time capture dataset was used in the tests, along with pre-trained CNN models such as VGG19, Mobile Net, and Inception v3 and ResNet152

Data Collection

The data source for this research problem contains image data of approximately 3012 both diseased and healthy banana leaf images were collected from different regions of South India, especially southern Tamil Nadu outside Madurai, Dindigul and other regions. The images were collected in various resolutions recorded using high-resolution mobile phones, VGA cameras, and DSLR camera systems.

RESULT AND DISCUSSION

The input size for The VGG19, Mobile Net, Inception v3 and ResNet152 is 224×224 . Despite the size of the dataset, which contains over 4,000 photographs of Banana leaf illnesses, the images match real-life images acquired by farmers using various image collecting techniques, such as high-definition cameras, and smart phones. Also, such a large dataset is prone to over fitting. Over fitting normalization strategies, such as data augmentation after preprocessing, were proposed to overcome this. The preprocessed photos were augmented with clockwise and anticlockwise rotation, horizontal and vertical flipping, zoom intensity, and rescaling. Because the pictures were not copied but rather enhanced during the training process, physical copies of the augmented images were not saved but



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were instead momentarily utilized in the process. This augmentation strategy not only minimizes over fitting and model loss, but it also boosts the model's resilience, allowing the model to classify true plant pathogens images with greater accuracy. Even when trained on high-end GPU processors, most cutting-edge models take days or weeks to train and adapt. It takes time to train and build a model from scratch. The batch size for training the model was set at 32, and Initial and fine turning 10 epochs were selected for validation and evaluating the model pictures for each illness. The transfer learning model has the benefit of learning quicker than models developed from scratch, as well as the ability to freeze layers of the model and train the last layers for more accurate categorization. Firstly, specific hyper parameter standardizations for various pre-trained models were conducted. The hyper parameter setting information is RMSprop optimizer was used to optimize the models. The VGG19, Mobile Net, Inception v3 and ResNet152, models starting learning rates were set at 0.0001. Each algorithm model was run for 10 for epochs, with the dropout value set at 0.2. Our experiment overcome over fitting and degradation concerns since the output graph began to converge after a few repetitions. For the identification of plant diseases, this section of the study used cutting-edge deep-learning algorithms and the transfer learning technique. The real-time collected information was utilized to train the previously learned deep CNN networks with the capture dataset. Every system was normalized for our research with a learning rate of 0.0001, a dropout of 0.2. The graph in Figure 3 displays the deep learning model's recognition accuracy and loss. The dataset was divided into three sections: training, testing, and validation.

80% of the Captured samples were utilized to train the pre-trained The VGG19, Mobile Net, Inception v3 and ResNet152 models. Each model was run for 30 epochs, and it was discovered that our model began to converge with good accuracy after 10 epochs. The graph in Figure 3(a) displays the Inception v3 model's recognition accuracy. The log loss of the Inception v3 model is shown in Figure 3a. The training accuracy and testing accuracy of the Inception v3 model was 95.71% and 94.87%. Using the same dataset, the second experiment tested the VGG-19 model. Following hyper parameter standardization, the model was trained using 80% of the same dataset, with 10% used for testing and the remaining 10% used for testing and validation. Figure 3(b) shows that the model recognition accuracy reached about 78% in the first 10 epochs, then progressively grew to the highest recognition accuracy of training and testing are 91.3% and 92.5%, which was lower than the Inception V3 model. The Mobile Net model was used in the third trial. The same procedure was used to evaluate model loss and recognition accuracy, and the resulting graphs for recognition accuracy, validation, and training loss are shown in Figure 3(c). This model training g and testing accuracy was 94.83 percent and 93.89%. It outperformed the models Inception V3 and VGG-19. Figure 3(d) after standardizing the hyper parameters, the last experiment was carried out with ResNet152, which contains 152 layers with three dense blocks and a transition layer between each dense block. Figure 3(d) depicts the training and validation accuracy/loss graphs for 30 epochs. The greatest accuracy attained in the testing phase following training and testing accuracy was 98.11% and 98.12%, while the maximum validation loss computed was 0.0154%. Table 5 displays a performance comparison analysis for the pre-trained network model trials. Figure 4(a), 4(b), 4(c), and 4(d) shows confusion matrix of deep learning model ResNet152, Mobile Net VGG19 and Inception v3

CONCLUSION

Banana leaf diseases lead to a drop in banana production quality, and diagnosing these diseases is extremely useful and provides a practical, simple, and suitable technique to increase banana output. The several transfer learning models suited for the correct categorization of banana leaf disease were examined in this article. The classification accuracy, sensitivity, and F1 score were used to standardize and evaluate state-of-the-art convolutional neural networks utilizing transfer learning techniques. ResNet152 outscored Mobile Net, VGG-19, and Inception V3 in a performance examination of the various pre-trained architectures. The ResNet-152 model appeared to be simple to train since it had fewer trainable parameters and lower computing complexity. As a result, ResNet-152 is more suited for plant disease diagnosis when a new plant disease must be incorporated in the model, owing to its lower training complexity. The suggested model achieved 98.3% classification accuracy and 99.1% F1 score.





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Table 1: Collection of Capture Banana leaf images data

Banana Leaf Disease	No of images
Banana Healthy	492
Banana Leaf Spot	419
Banana Yellow Sigatoka	588
Banana Black Sigatoka	1123
Banana Panama Wilt	390
Total	3012

Table 2: Performance comparison analysis for the pre-trained network models

Model	Training Accuracy (%)	Testing Accuracy (%)
VGG19	91.3	92.5
InceptionV3	95.7	94.8
Mobile Net	94.8	93.8
ResNet152	98.3	98.1

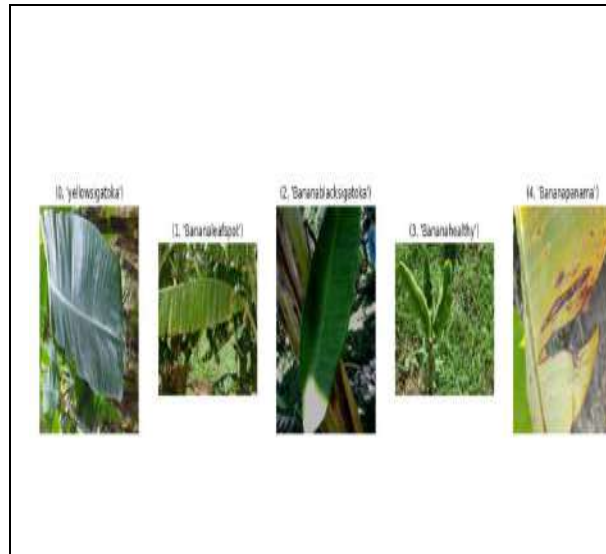
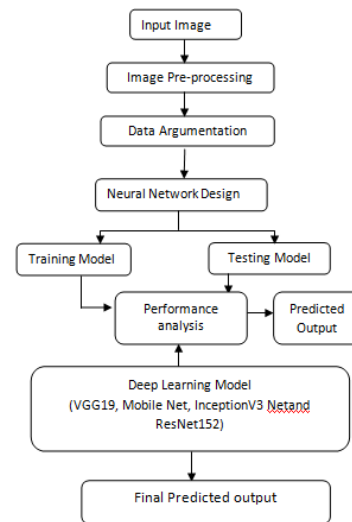
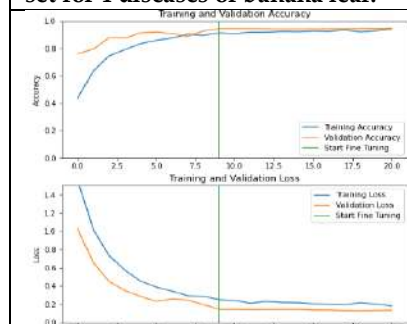
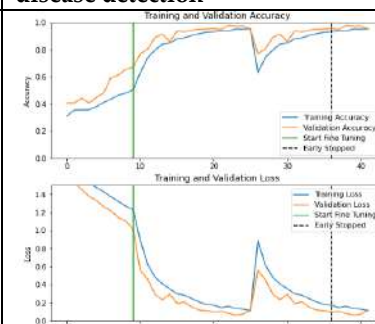




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Table: 3 Computational Time for Various Model

Model	Computational Time	
	Training Time(min)	Testing Time(min)
VGG19	4.851	2.482
Mobile Net	3.785	2.23
Inception v3	3.268	2.11
ResNet152	2.225	1.68

**Figure: 1 Sample input images from real time Data set for 4 diseases of banana leaf.****Figure: 2 Deep learning based overall framework for plant disease detection****Figure 3:(a)Recognition accuracy and loss for Inception Net****Figure 3: (b) Recognition accuracy and loss for VGG19**

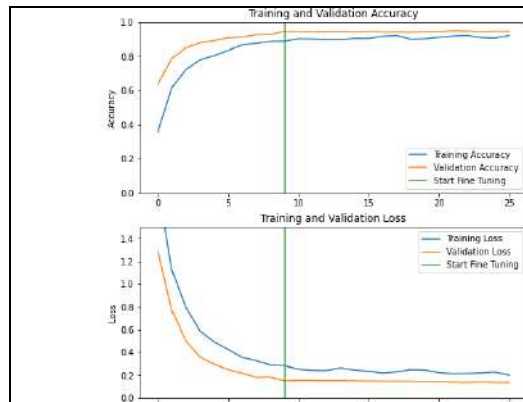


Figure 3: (c) Recognition accuracy and loss For Mobile Net

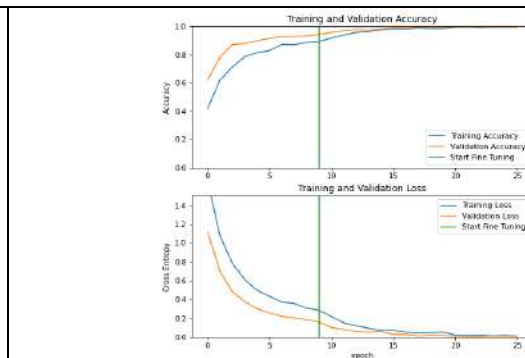


Figure 3: (d) Recognition accuracy and loss for ResNet152

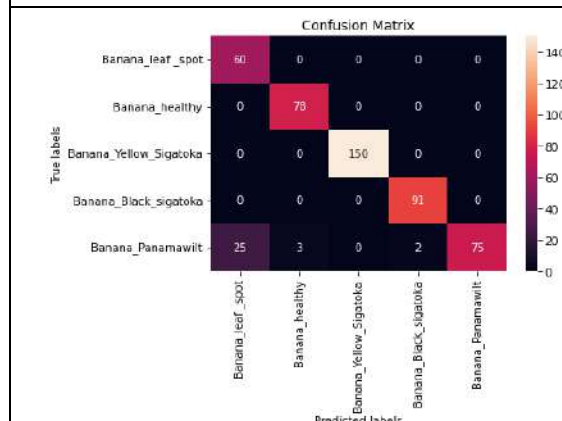


Figure 4: Confusion Matrix of ResNet152 Model

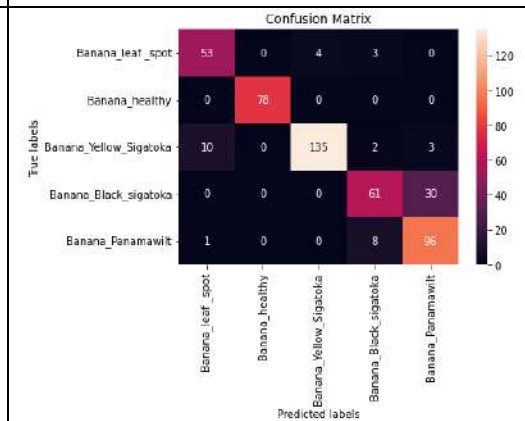


Figure 4: (b) Confusion Matrix of Mobile Net Model

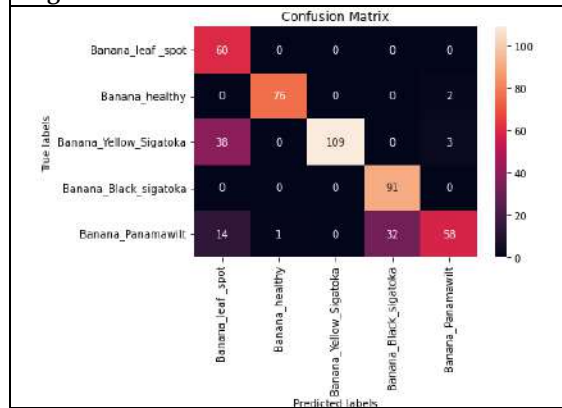


Figure 4: Confusion Matrix of (c) VGG 19 Model

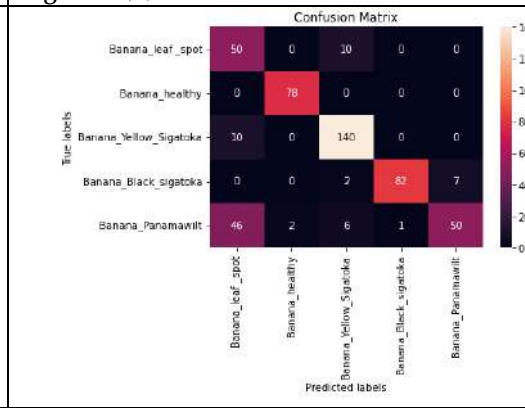


Figure 4: (d) Confusion Matrix of Inception v3





A Comprehensive Review on CO₂ Flooding for the Application of Enhanced Oil Recovery

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ABSTRACT

CO₂ flooding is a method used to enhance the recovery of oil from reservoirs by injecting carbon dioxide. When CO₂ comes into contact with the oil, it expands and propels the oil towards the production well, increasing the amount of oil that can be extracted. Compared to other EOR methods, CO₂ flooding has several advantages, including high recovery rates, low costs, and minimal environmental impact. Additionally, the CO₂ captured during this process can be buried to reduce greenhouse gas emissions and mitigate climate change. CO₂ flooding is most effective in reservoirs with high permeability and evenly distributed permeable layers, and a proper trap configuration is required to prevent CO₂ leakage. The technique also reduces the viscosity and mobility of the oil, making extraction easier. However, the reservoir pressure must be maintained at a certain level for optimal results, as low pressure may not allow the injected CO₂ to efficiently displace the oil. This review aims to provide a comprehensive analysis of CO₂ flooding techniques and global research on the subject to enhance the efficacy of the methods in practical field applications.

Keywords: Enhanced Oil Recovery; CO₂ Flooding; Sweep Efficiency; Carbon Capture and Storage; Water Alternating Gas; Carbonated Water Injection





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INTRODUCTION

CO₂ flooding is a process used in enhanced oil recovery (EOR) to extract more oil from depleted oil reservoirs. This process involves injecting carbon dioxide (CO₂) into the reservoir to displace the remaining oil and push it towards the production wells. The process of CO₂ flooding is based on several physical and chemical mechanisms, such as the solubility of CO₂ in oil, the reduction of oil viscosity, and the swelling of the reservoir rock. CO₂ can also physically displace the oil towards the production wells, further increasing oil recovery. CO₂ flooding has several advantages over other EOR methods. Firstly, it is a clean and environmentally friendly process as it uses carbon dioxide, which is a naturally occurring gas, and does not produce harmful pollutants. Secondly, it can significantly increase the amount of oil recovered from a reservoir, sometimes by as much as 20-30% of the original oil in place. Overall CO₂ flooding is a promising technique for enhanced oil recovery, and ongoing research aims to optimize its performance and reduce its costs to make it more widely applicable.

MECHANISM OF CO₂ FLOODING

There are a lot of mechanisms being used in CO₂ flooding. Most commonly, Carbon dioxide is captured and compressed to a near liquid state and transported via pipeline for enhanced oil recovery (EOR). EOR with permanent CO₂ sequestration or storage is a process where CO₂ is injected into deep reservoirs to improve oil production and is a technique already being used. The CO₂ is injected in a near liquid state to a large depth underground. The CO₂ travels down the wellbore to a precise and predetermined location within the rock formation that provides the greatest enhanced oil recovery and permanent CO₂ storage benefit. As the CO₂ mixes with the oil in the formation, the oil swells reducing its viscosity, allowing the oil to flow more easily through the interconnected pore spaces towards the production well which can result in 10% - 13% more oil production. Some trapping mechanisms include the dissolution of CO₂ in formation fluids and mineralization of the CO₂ within the rock pore spaces. Sometimes CO₂ is injected alternatively with water which is known as Water Alternating Gas or WAG process. Yong Yang performed an experiment and found out that CO₂ flooding combined with the use of chemical modifiers can significantly boost oil recovery. The economics of CO₂ flooding appears to be significantly improved by modifiers. It has been discovered that toluene-modified CO₂ is more miscible with crude oil than pure CO₂. When toluene is added, both the conversion of CO₂ into oil and the extraction of oil into CO₂ had incremental increases of 251% and 64%, respectively. Oil recovery from CO₂ flooding can be increased by 22.5 percent in contrast to CO₂ alone by pre-slug injection with the addition of high toluene concentration. CO₂ overflow.

The application of CO₂ can be efficiently expanded when modified with toluene, particularly when CO₂ and crude oil are partially or completely immiscible.[6] Zheng Chen carried out an experiment and found out that the fastest growth in oil output occurs at the gas breakthrough stage, but this is also the stage with the lowest injection capacity. Less oil is produced, the injection index rises sharply, and the injection capacity improves when gas channelling occurs. Furthermore, the core pressure rises as the gas injection rate increases. Additionally, there is an improvement in the way that CO₂ dissolves and mixes with crude oil. Additionally, the injected gas has a better sweep efficiency, which raises the ultimate recovery factor and the supercritical CO₂ consumption. There is an ideal range for increasing the injection rate, although doing so only partially delays the emergence of gas channelling. After gas channelling, the gas-oil ratio with low water saturation rises significantly, yet the injection capacity is effectively managed. As a result, it's critical to pick the right gas injection time at each stage of water flooding.[7] Rui Wang did certain experiments and found out that in high water cut reservoirs, the response to CO₂ flooding is significantly delayed, according to the results of laboratory and pilot testing. The performance of the response increases simultaneously as the water-cut goes down and the rate of oil recovery goes up. In high water saturation, the dissolving loss of CO₂ must be compensated. To counteract the influence of the water shielding phenomena on CO₂ flooding, the CO₂ EOR injection scenario for high water-cut reservoirs should use a fairly long soaking duration and a greater pore capacity of CO₂. This strategy provides better prospects for mature oilfields vulnerable to CO₂ flooding, which have been verified by field tests for production performance.[8] Jesús Alberto Pérez-Romero



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discovered that this beneficial effect under synergistic root-flooding was primarily due to upregulation of its energy sink capacity, as indicated by the increase in reaction centre turnover rate, relative PQ pool size, and connectivity between PSII units, along with the previously mentioned increase in carbon assimilation and water balance capacity. Our findings also showed that a greater modulation of the antioxidant enzyme machinery and of the beta in accumulation on tissues to cope with oxidative stress, as well as a great presence in saturated fatty acids, which would be associated with the aforementioned improvement in the PSII function, were responsible for the beneficial effect of CO₂ concentration.[9] Surfactants, NPs and a mixture of both help to stabilise CO₂ foams. Although miscible CO₂ flooding has a significant potential to enhance residual oil recovery, it has poor sweep efficiency. By making the foam more viscous, CO₂ foam flooding offers an answer to problems with mobility control. NPs-surfactant-stabilized CO₂ foams are almost 2 to 20 times more stable than foams stabilised by surfactants, according to a review of foams compared to foams stabilised just with NPs or surfactants, more stable. If this hybrid technique is perfected, the increase in foam viscosity may result in improved oil recovery from oil reservoirs. Our analysis leads us to the conclusion that NPs-surfactant stabilised CO₂ foams are promising EOR agents, however a more effective for their field implementation, substantial research is necessary because real reservoir operational, temperature, and salinity conditions the action of NPs and surfactants can be dramatically impacted by pressure.[10]

Zhou Tou found out that when CO₂ floods, which often occurs when the displacement pressure exceeds the minimum miscibility pressure, reservoir blockage may result. The blockage phenomena will certainly limit production capacity, but it has no effect on the pattern of CO₂ flooding efficiency with pressure. When CO₂ interacts with crude oil, component differentiation takes place. As a result, light components travel quickly while heavy components accumulate and obstruct pore throats, which is one of the main processes of CO₂ flooding blocking. The key strategy for avoiding reservoir obstruction is to regulate displacement pressure. The ideal CO₂ pressure the lowest miscibility pressure should be when flooding occurs. Overly-high and under-low pressure are not favourable for CO₂ floods.[11] A case study of Chang 8 block in Changqing oilfield, NW China showed that the majority of the inorganic salt precipitate formed during the CO₂-formation where water reaction is CaCO₃, and the amount of precipitate is inversely related to the temperature, mass concentration of scale-forming ions, and pressure difference. Precipitation amount is the rate at which core porosity changes a favourable correlation between before and after CO₂ floods temperature and pressure difference due to displacement. Due to the increase in porosity, the precipitation always less than that of creation water group cores of distilled water. The majority of precipitates will eventually be formed close to the production well with continuous CO₂ injection. CO₂ flooding development has greatly enhanced the floodplains compared to water flooding development.

Recovery rate has raised from 15% to 20%. The impact of oilfield development has worsened as a result of the significant accumulation of precipitation in the well group. The rate of block recovery is 33.45% when precipitation is taken into account, and 37.64% when precipitation is not taken into account.[12] Hai-Bo Li stated the mechanism of CO₂ flooding in shale reservoirs that when compared to non-supercritical N₂ and CO₂ flooding, CO₂ flooding showed clear benefits since it could achieve a high oil displacement recovery. The average oil recovery of the six samples at supercritical CO₂ flooding experiments on crude oil-saturated cores was at 46.98 percent of the displacement was at comparatively modest pressures (9.56 MPa), and the seven samples' combined average oil recovery at high displacement. The percentage of pressures (16.95 MPa) was 73.35. The reservoir obstruction was severe because the permeability of core samples after CO₂ flooding was only 28% to 64% of that before flooding. Asphaltenes usually decreased in the ejected oil, and non-hydrocarbons partially decreased. As saturated hydrocarbons of several samples were found in high back pressure. Before gas occurs in the 12 MPa displacement process in the slim-tube tests, the amount of the expelled oil was substantial, and the oil evacuated in various stages had corresponding characteristics; as the pressure rose to 13-24 MPa, At this pressure level, relatively little oil was released; As the pressure reached 30 MPa, heavy oil constituents were ejected. Mostly heavy components were released from the oil at 30 MPa. Asphaltenes and nonhydrocarbons were less abundant, whereas the content of C20-C34 had increased. A decent bottom hole existed.[14] After thorough analysis of the rock and fluids employed for this work, incremental oil recovery by WAG injection has been examined through core flooding tests. A higher WAG ratio produces better oil. But depending, it might result in an early breakthrough on a large distribution of reservoir heterogeneity and



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weak miscibility. An incremental recovery of 26.7 percent was seen with a WAG ratio of 1:1. WAG ratio of 1.5:1 and over water flood have demonstrated incremental recovery over the water flood was 31.57%. However, the WAG ratio of 2:1 has demonstrated a 33.51 percent incremental recovery from the water deluge. Just 1.94 percent OOIP increase from 1.5:1 to 2:1, has been seen to be recovering. Therefore, it has been determined that a dose of 1:1.5-2:1 is the ideal ratio for the WAG process to promote improved recovery. These reservoir scale characteristics have been screened this may be scaled up in the same manner. The outcomes of the simulation highlight the significance of WAG injection. The combined effect of CO₂ injection and water alternative standard state for hydrocarbons. LPG injection and related gases likewise exhibits comparable responses to CO₂ injection. As a result, it can be said that the WAG injection technique can increase the hydrocarbon production.[15] The CWI technique demonstrated excellent results in terms of the enhanced oil recovery and carbon storage, according to the micromodel findings. The residual oil recovery factor could drop from 67 percent to 32.7 percent as a result of a subsequent water flooding following the CWI. Oil expands following CWI, with a swelling factor of 94% for light oil and 23% for heavy oil respectively.

The likelihood of CWI alternating is higher. Calcite, a key component of carbonate, has a contact angle. The angle ratio before and after treating the water with carbon dioxide is 1.50 for old calcite and 1.14 for unaged calcite, respectively. According to the composition of the LKC formation brine, which is roughly 0.7 molarity under reservoir circumstances, high salinity brine exhibits poor solubility of CO₂, while low salinity brine solubility varies between 1 and 1.4 molarity. Due to image analysis and core flooding test of CWI show that both deposition and dissolution are observed to occur in the process. Approximately 60 PVs were injected, and the porosity decreased from about 17 percent to 16 percent. After approximately 160 PVs were injected, the porosity increased to approximately 19 percent. These phenomena enabled field operations to be optimised in order to avoid injectivity problems.[16] Mohammad Hossein Ahmadi experimented and found out that Surfactant-polymer (SP) flooding, supercritical carbon dioxide flooding, and foam flooding are all regarded as hybrid chemical flooding techniques that improve oil recovery. In the experimental evaluation's miscible condition was SP-foam flooding has recorded the highest overall oil recovery percentage (about 78%) because of the greatest pore throat obstruction allowing for greater mobilisation of the fluids in low permeability layers. SP-CO₂ flooding and direct foam flooding had completed because of the decreased foam, the cumulative oil recovery factor was smaller decreased obstruction and increased generation in highly permeable layers. For direct foam flooding and SP-CO₂, it is roughly 70% and 64%, respectively. Additionally, SP-foam mode had offered the greatest pressure loss (compared to 0.27 MPa) at the induced by core flooding.[18]

METHODS OF CO₂ FLOODING

Water Alternating Gas (WAG)

The outcomes of the reservoir simulation are used to draw some significant conclusions from the WAG approach. The WAG technique enhances reservoir total recovery by lowering the mobility ratio between oil and water phase and increasing sweep coefficient. The amount of oil recovered from the reservoir is impacted by the WAG cycle period used during the WAG injection procedure. High WAG time ratios are favoured over low WAG time ratios for oil recovery, however the scenario will be totally different for CO₂ storage.[19] Utilizing wag is a productive approach to increase productivity by reducing viscosity of oil. In the WAG method, CO₂ can penetrate into the oil phase, increasing oil swelling and, as a result, increasing oil recovery. Incomplete diffusion results in a reduction in WAG efficiency. Water in the oil-gas transition zone can interfere with the transmission of gas, making it difficult to disperse gas. CO₂ can seep into the oil phase during the WAG process, which causes the oil to swell more and leads to more oil recovery. If the diffusion process is not fully completed, WAG efficiency declines. Gas transmission processes may be hampered by water present between the oil and gas phases, making it difficult for gas to diffuse[20]. By combining the benefits of gas injection with water flooding, WAG is regarded as a trustworthy technique that improves oil recovery. High microscopic sweep efficiency is provided by the gases in a WAG process, while the addition of water enhances macroscopic sweep efficiency. Injection of WAG lowers CO₂ consumption. [21] Water alternating gas (WAG), that combines the benefits of water injection and CO₂ injection, may increase sweep efficiency and displacement efficiency. It has also been proven to be successful in mobility control, as shown by several field applications. Immiscible WAG was used to extract oil from low permeability cores, and the findings



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demonstrate its efficiency. As it is known that CO₂ tends to breakthrough due to the viscosity difference between gas and oil, water alternating gas (CO₂) was introduced. The oil recovery after water injection is about 30% OOIP. As the gas and water are injected in turn, the oil recovery increases. The ultimate oil recovery differs as a result of the differences of fluid volume injected. The highest oil recovery reaches 50% OOIP with incremental oil recovery over 20%. [22] By regulating the mobility of both water and gas, the water alternating gas (WAG) EOR method improves oil recovery. Gas is injected into the reservoir as part of the WAG process, and then water serves as a chasing fluid. It consists of two steps: first, gas is pumped into the reservoir, where it combines with the crude oil to cause swelling and a decrease in viscosity, enhancing the oil's mobility. As a result, gas that is inaccessible to water will displace oil from the pores. Due to the increased viscous force in pores, injection water also enhances oil recovery. By stabilising the displacement front during water injection and lowering viscous fingering, WAG is used to regulate water mobility. The WAG procedure also lessens the influence of gas override during gas injection. Consequently, by using this method, both the macroscopic and microscopic sweep efficiencies are increased.[23] Foam-aided WAG is a prospective EOR method that raises oil recovery by enhancing the reservoir's macroscopic sweep efficiency. Foam quickly destabilises at high temperatures in a crude oil environment, limiting the utility of this method.[10]

Combining the advantages of water flooding (WF) and GI procedures, the water-alternating-gas (WAG) injection technique is an effective way to re-cover hydrocarbons. The WAG injection is regarded as a mature and trustworthy enhanced oil recovery (EOR) technique in the oil and gas sector for releasing the trapped oil following the basic WF operation. In fact, the WAG strategy is recommended as a successful EOR technique to increase the efficiency of the macroscopic sweep and lower the expenses of the GI process. [6] Since gas may be more easily mobilised through pores and cracks, WAG has a greater oil recovery than standard oil recovery techniques. Combining the two techniques WAG and SAG would be important to increase the oil recovery from tight reservoirs since surfactant and carbon dioxide are applicable in terms of reducing interfacial tension and controlling mobility.[24] Carbon dioxide (CO₂) was chosen above other gases for the WAG injection because of both its ability to produce better recovery factors than other gases and its ability to reduce greenhouse gas emissions. These factors have motivated researchers to assess the CO₂ -WAG injection's potential to increase oil production from poor permeability sources.[25] The ultimate oil recovery as well as the density and viscosity of the fluids can be affected by mass transfer that can take place between the invading and in-situ fluids throughout the WAG injection process.[26]

Carbonated Water Injection (CWI)

If the diffusion process is not fully completed, WAG efficiency declines. Gas transmission processes may be hampered by water present between the oil and gas phases, making it difficult for gas to diffuse. Consequently, it is vital to employ a successful alternate technique. A possible alternative approach that can mitigate the mentioned drawbacks is carbonated water injection (CWI). Carbonated water, or water that has been saturated with CO₂ can stay a single phase under reservoir conditions. Additionally, it is more efficient than both gas injection and water flooding separately. Oil swelling can occur as a result of CO₂ moving from the water phase into the oil phase during CWI. It should be emphasised that unfiltered intrinsic water, or CO₂ enhanced water, might exist between the first oil in situ and the CW.[20] The technology named carbonated water injection (CWI) involves dissolving Carbon dioxide in formation water under pressure and injecting the mixture to replace the oil. Because CO₂ is readily soluble in oil, it moves from formation water to oil during displacement, causing oil to expand and viscosity to decrease as a result. Additionally, according to some researchers, CW will affect wettability, which will boost oil recovery and imbibition rates. Using various types of cores or sand packs, several researchers have run tests to investigate the performance of CWI under various pressures and temperatures. The incremental oil recovery varied between 12 and 40%.[22] Before being injection into to the reservoirs during in the CWI process, CO₂ is dissolved in the water phase. Due to the chemical potential difference between the CO₂ in the two phases (acting as a driving force), the dissolved CO₂ can move from the water phase to the oil phase. As a result of this interfacial mass transport, the oil is becoming less viscous, the oil-water interfacial tension (IFT) reduces, and oil swells, which results to the reconnecting of isolated residual oil ganglia and the mobilisation of the trapped oil (after WI) for production. Following CWI, these mechanisms will lead to a greater oil recovery factor. One of the key benefits of CO₂ dissolving (in oil) is the reduced oil viscosity, which increases oil mobility. The primary uses of CWI are in operations for carbon sequestration, re-



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mediation, and increased oil recovery. The preparation of CW, corrosion, scale formation/asphaltene precipitation (around the wellbore area), the water weakening impact, and high capital, operating, and maintenance costs are the prevalent practical issues with the CWI implications for improved oil recovery operations.[27] It is known as carbonated water injection when CO₂ has been dissolved in formation water under a certain pressure and re injected into the reservoir (CWI). Following the water injection scenario, carbonated water with concentrations of 1, 2.5 and 5 PV was added to examine the oil recovery. By lowering oil viscosity, carbonated water injection (CO₂ dissolved in water) provides optimum oil swelling. Due to a large reduction in water blockage, it has shown better outcomes than CO₂ injection. Oil recovery factor increased as carbonated water concentration rose. For pre-water injection with carbonated water of 5 PV, it has a maximum oil recovery ratio of 60%.[28] As a result of CO₂ progressively transitioning from water to oil throughout this process, oil recovery is improved. For tight formations when there is a lack of CO₂ supply, CWI is an alternative EOR approach since it can decrease gas breakthrough and increase displacement efficiency.[29] In comparison to the traditional WF, it was discovered that the CWI technique results in a greater oil recovery. Additionally, the core served to store some of the injected CO₂. [30]

A CO₂-augmented water flood (WF) technology, carbonated water injection makes efficient use of relatively modest amounts of CO₂ without the requirement for a large source of CO₂. [31] Oil swelling and oil viscosity reduction, wettability alternation, and interfacial tension reduction are three categories of CWI mechanisms that contribute to increased oil recovery. Oil swelling is seen to be more crucial for recovering light oil, whereas viscosity decrease is thought to be more crucial for recovering heavy oil.[16] There is a lot of interest in enhancing oil reservoir recovery while addressing worries about rising CO₂ levels in the environment. Carbonated (CO₂-enriched) water injection can be used to combine Enhanced Oil Recovery (EOR) and secure geologic storage of CO₂ in oil reservoirs (CWI). The efficiency of CWI for oil recovery and CO₂ storage potential on heterogeneous cores has not been studied, despite the fact that several core flood experiments on homogeneous cores have been conducted. CWI revealed the high potential for safe underground CO₂ storage in heterogeneous reservoirs in addition to its great oil recovery.[32] The oil recovery of secondary CWI is much higher than that of tertiary CWI, indicating that CO₂ solubility in brine is a more important factor controlling the effectiveness of the CWI process than the minimum miscibility pressure (MMP) between CO₂ and the oil.[33]

Active Carbonated Water Injection (ACWI)

On the basis of CWI, active carbonated water injection incorporates surfactant. When combined with ACWI, CO₂ performed significantly better than when it was injected alone. Surfactant reduces interfacial tension noticeably, allowing for greater mobilisation of remaining oil. As a result, under the identical conditions, ACWI's EOR performance is superior to CWI's.[22] To reduce the interfacial tension and the amount injected into the system, carbonated water and surfactant were combined. It can therefore accomplish the same results as carbonated water at smaller pore volumes. The increase in active carbonated water has led to better oil recovery. It has a maximum oil recovery factor of 64% with the carbonated water of 1 PV, which improves gas transfer to the oil phase. Therefore, the introduction of a surfactant would be an appropriate chemical agent to reduce the interfacial tension and carbonated water volume required in the injectivity situations at smaller pore volume injections. Active carbonated water injection (ACWI) shown a higher efficiency on enhancing oil recovery when compared to other scenarios. The system's carbonated water injection volume can be reduced by lowering the interfacial tension by adding surfactant to the carbonated water. It can therefore provide the same effects as carbonated water in smaller pore volumes. The surfactant concentration must first be optimised before being used in ACWI injection.[28]

TECHNOLOGIES OF CO₂ FLOODING

Mass transfer of constituents between crude oil and CO₂

A peculiar phenomenon in the development of gas flooding is mass transfer of components from gas to liquid. The mass transfer between the CO₂ and hydrocarbon components of crude oil is complicated because of the high wax and heavy hydrocarbon contents in continental crude oil (like in China) as well as the typically supercritical state of CO₂ under formation temperature and pressure. In terms of mass transfer and phase transition with CO₂, three distinct types of crude oil behave quite similarly. The oil-CO₂ boundary may be seen clearly at the starting pressure



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(10 MPa). The amount of oil phase grows and the amount of gas phase decreases as pressure rises as CO₂ gradually dissolves into the oil. Right now, CO₂ dissolution in the oil phase is the primary mechanism for mass transfer between the oil and gas phases. Additionally, the oil phase becomes lighter due to CO₂ dissolution. The mass transfer rate quickens while pressure keeps building, extracting significant amounts of crude oil's components. Additionally, when the pressure increases, the mass movement speeds up; the liquid characteristics of the gas phase increasingly emerge, and the liquid phase's gas properties are further improved.

Microscopic oil displacement mechanism of CO₂ flooding

Injection pressure, pore size, interfacial tension and flooding timing are key factors affecting microscopic oil displacement effect of CO₂ flooding. According to tests on how pore size affects the microscopic CO₂ flooding mechanism, miscibility progresses steadily from large pores to small holes as pressure increases. The minimum miscible pressure will grow with pore size under the identical circumstances, but the increase in minimum miscible pressure's amplitude is not immediately apparent. The lowest miscible pressure for 20 m holes, for instance, is roughly 0.2 MPa higher than that for 400 m pores at 50°C. The findings of tests on microscopic scales with CO₂ flooding at various interfacial tensions reveal that at high interfacial tension (8.32 mN/m), CO₂ displaces crude oil initially in the centre of the pore as a non-wetting phase, their interface is clear, and slug-like movement develops. Additionally, because interfacial tension prevents CO₂ from entering narrow pores, crude oil in those pores is virtually ever retrieved. CO₂ may easily peel off the oil films at the pore edge layer by layer at low interfacial tension (0.91 mN/m), causing the oil to float in CO₂ in a dispersed form. Moreover, the interfacial tension is reduced, allowing CO₂ to more easily enter the microscopic pores and improving the recovery of crude oil in them. To determine the impact of CO₂ flooding time on development effect, direct CO₂ flooding and CO₂ flooding after water flooding were both carried out under the miscible condition of CO₂-crude oil. When CO₂ is injected after water flooding, the distribution of the water and oil becomes extremely complicated. Some oil is encapsulated by the water, which prevents it from contacting the CO₂ that will be injected later. As a result, this oil cannot be recovered. Most of the oil in various pores is retrieved in the event of direct CO₂ flooding. The minimal miscible pressure in direct CO₂ flooding is lower because water phase interferes with the miscible process of CO₂-crude oil.[34]

Design of reservoir engineering parameters

According to the principle of 'maintaining pressure to promote miscible state, and alternating water and gas to control fluidity', reservoir engineering parameters for CO₂ flooding and sequestration, such as layer combination, well pattern deployment, and injection scheme, are designed, optimised, and adjusted based on the reservoir's geological characteristics and gas flooding characteristics. The control of gas flooding and the establishment of an efficient displacement system are the key factors taken into account in the design and adjustment of well pattern and well spacing. On the basis of "maintaining the balance between miscible pressure and production rate in reservoirs," gas injection rate and flow pressure control of producers are optimised. The relationship between the maximisation of recovery factor, the utilisation ratio of injected gas, and the capacity of the surface system to handle produced gas should be taken into account while designing the cumulative injection volume. A good technique in alternate water-gas injection. The gradual water-gas slug mode is preferred for gas flooding because of the characteristics of multi-layers, strong heterogeneity, and relatively insufficient capacity of gas source supply and surface treatment facilities.[34] Although miscible CO₂ flooding has a significant potential to enhance residual oil recovery, it has a poor sweep efficiency. By making the foam more viscous, CO₂ foam flooding offers an answer to problems with mobility control. Foam stability in reservoirs over the long term, however, is a problem. By regulating phase mobility, surfactant-stabilized foam flooding has been utilised to enhance oil recovery from oil reservoirs. However, it might be difficult to create a stable foam and maintain it in porous material when there is oil present. Because of their high adsorption energy, superior surface qualities, and capacity to irreversibly bind at the fluid-fluid interface, NPs have been widely used as emulsifiers and stabilisers for foams and emulsions.[35]

Phenomena of water shielding

The phenomenon of water shielding is important, particularly for mature oilfields with exceptionally high water cuts. Due to the high water saturation, injected CO₂ would be occluded by water film. The impact of the water



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shielding phenomena on the displacement characteristics of CO₂ flooding was demonstrated using a micro-visualization experimental setup with a high-pressure cell. A visual cell, an injection and production control system, a heating system, and a camera and image processing system make up the four basic components of the micro-visualization experiment apparatus. The visual cell's maximum operating pressure and temperature can be increased to 70 MPa and 300 C, respectively. The thickness of the water film determines how much of a protection there is against water.[36]

On-line monitoring technology for internal corrosion of CO₂-EOR

Monitoring for corrosion is a crucial early warning system for the security of oil field operations. Different corrosion monitoring techniques are frequently employed in the evaluation of the corrosion risk of critical pipelines and equipment, such as the oilfield production system, which has evolved into the essential assurance for oilfield production. The risk of corrosion for oil field production systems has significantly increased in recent years due to the rise in water cuts. Corrosive gases like CO₂ and H₂S enter the production system together with the produced fluid when new technologies like CO₂ oil drive and heavy oil thermal recovery are used, which increases the corrosiveness of oil production and infusion fluid. Corrosion online monitoring and risk assessment are especially crucial in the current environment of oilfield development to maintain safe production. Resistance probe, electrochemical probe, and inductive probe are the three most prevalent corrosion monitoring approaches in terms of testing mechanisms. They include the electrochemical probe, which has the advantage of speedy reaction but necessitates that the medium being tested have a high conductivity, and the resistive probe, which measures resistance by corrosion-induced cross-sectional change. The inductive probe, which has good accuracy and stability and is widely used in petrochemical businesses both domestically and internationally, is used to gather corrosion data by measuring the change in inductance induced by metal corrosion.[37]

Transformation of technologies for CO₂ utilisation

It is important to stress that CO₂ utilisation methods by itself cannot sufficiently reduce CO₂ emissions. As an example, it is anticipated that the worldwide chemical sector will use 15.42 GTCO₂ cumulatively from 2010 to 2050, which equates to nearly 2% of the CO₂ reduction goals for that year. In order to meet CO₂ reduction goals, CCUS has become a more popular and lucrative concept in respect of the economic benefit of CO₂ utilisation and CCS for long-term CO₂ storage. However, CCS technologies are outside the preview of this review paper, and there are a number of worthwhile discussions elsewhere. It is of huge importance to discuss CO₂ utilisation technologies.[39]

Ammonia-based CO₂ capture process

One of the most commonly used sorption techniques is ammonia-based CO₂ collection. Among the technical issues with this procedure, preventing ammonia from escaping is the most important challenge. The majority of ammonia-based recovery plants use water washing, which is a relatively efficient and established method. Most of the time, it is possible to limit the amount of released ammonia. While the NH₃ abatement and recycling process requires more resources and energy consumption. A number of novel techniques, such as the utilisation of multi-stage absorption columns and the integration of flue gas pre-treatment and desulfurization, offer an efficient means of lowering water and energy consumption. Further research must be done on these viable processes. Further research must be done on these viable processes.[40]

Technologies and infrastructures underpinning future CO₂ value chains

Each technology's operating system is described and in order to determine which technologies can offer the most attractive investment prospects for achieving energy demands and emissions targets, the technologies are assessed based on their technical, socioeconomic, and environmental advantages and limits. The Technology Readiness Level (TRL), a measurement of technological maturity that ranges from fundamental observable principles to fully functional chemical processes, is used to categorise each technology. The European Commission's TRL classification, which is based on a scale from 1 to 9, has been applied in this work. The technologies are compared based on TRLs and gate-to-gate1 key performance indicators (KPIs), such as capital expenditure (CAPEX), operating expenditure



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(OPEX), product price, net carbon dioxide utilisation, and energy requirements. Other parameters, such as water consumption and plant operational lifetime, are also provided where they are available.[41]

LSWA CO₂ EOR technique on improvement of oil recovery in sandstones

A developing EOR method known as low salinity water flooding primarily affects the interactions in crude oil-brine-rock (CBR) systems. The WAG process is a widely used and effective EOR technique that plays a significant part in stabilising the fluid injection displacement front through mobility control, hence improving oil recovery. Therefore, by encouraging the mechanisms behind each process, combining the two procedures as low salinity water-alternating-CO₂ injection can further improve oil recovery.[23]

Current Technologies on Low Concentration CO₂ Capture

Only "direct air capture" (DAC) could lower the global atmospheric CO₂ concentration in the atmosphere for large-scale deployment of the carbon capture and storage (CCS) process, but control technology was difficult to implement. Additionally, regeneration materials have to be taken into consideration in manned restricted space because of the difficulties in replenishing supplies. Contrary to the condition in the atmosphere, CO₂ capture in occupied tight places is quite special and more challenging. Controlling the CO₂ concentration is essential for keeping the crew members of the space station healthy. To advance the creation of sustainable and manageable regeneration technology, regeneration materials must be taken into account.[43] The Supercritical CO₂ flooding technology, which is regarded as a clean and effective shale gas mining technique, is ecologically friendly and can boost shale gas production. Supercritical adsorption offers a method to forecast the estimation of methane adsorption capacity in shale reservoirs by converting surplus adsorption to absolute adsorption using the adsorption potential hypothesis.[44]

ENVIRONMENTAL IMPACT STUDY AND TECHNO-ECONOMIC ANALYSIS

The most efficient and cost-efficient technique for lowering CO₂ emissions from burning fossil fuels is currently CO₂-enhanced oil recovery (CO₂-EOR) and storage. The CO₂ sequestration mechanism should be in a supercritical state because the reservoir pressure and temperature are both higher than the critical point of supercritical CO₂. [5] Recent studies have shown that storing CO₂ in oil reservoirs during CO₂ flooding in oilfields can significantly lower CO₂ emissions. The goal of the CO₂ enhanced oil recovery (EOR) method proposed known as storage-driven CO₂ EOR, is to achieve net-zero or even negative CO₂ emissions by sequestering the most CO₂ possible in oil reservoirs while achieving the highest oil recovery. Dimethyl ether (DME) is a highly effective tool for improving CO₂ sequestration in reservoirs while supporting conventional CO₂ EOR for oil recovery. The quantity of CO₂ sequestered in storage-driven CO₂ EOR is more than the emissions from burning the oil generated; thus, the sequestered CO₂ balances both present and historical CO₂ emissions. In comparison to traditional CO₂ EOR, storage-driven CO₂ EOR offers a higher CO₂ storage ratio in oil reservoirs. The CO₂ storage ratio is further enhanced by the use of water alternating gas injection. Because the CO₂ emissions from burning the generated oil are greater than the sequestered CO₂ from storage-driven CO₂ EOR, the sequestered CO₂ cancels out both present and previous emissions.[45]

CWI encourages geological CO₂ storage with a large storage capacity. The ability to store CO₂ seems to be an extra advantage when CWI is used. CWI is being offered for EOR and CO₂ sequestration in numerous ongoing research and industry projects in the field of carbon management.[27] Aquifer-based carbon capture and storage (CCS) is a successful technology to reduce GHG emissions and achieve decarbonization. The level of technology, the amount of the carbon dioxide (CO₂) source, and the quality of storage are the main determinants of CCS cost. The requirements can be met using enhanced oil recovery (EOR) technology employing CO₂. The process of CO₂ EOR is comparable to CCS and has been in operation for more than 35 years. Additionally, a significant quantity of CO₂ can be permanently stored in oil reservoirs.[47] Gravity segregation is helpful for enhancing the potential for CO₂ sequestration. Gravity's effect on CO₂ sequestration decreases as pressure rises. The best oil recovery and gas sequestration potential of CO₂ flooding is attained under miscible circumstances, regardless of whether there is a gravity impact. Under immiscible conditions, the top gas injection that completely exerts the gravity effect can





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achieve the largest CO₂ sequestration. The effect of gravity on CO₂ sequestration decreases as pressure rises.[48] Because it is inert and doesn't harm the environment, nitrogen can be utilised in place of CO₂. [49]

CONCLUSION

The following conclusion may be drawn based on critical analysis of the multidisciplinary approach and comprehensive analysis of CO₂ flooding techniques in global perspectives: CO₂ flooding has been a viable solution for reducing CO₂ emissions while enhancing oil recovery and sequestering CO₂ in oil reservoirs. At present, the CO₂-EOR and storage are the most efficient and cost-effective techniques for reducing CO₂ emissions from large-scale fossil fuel burning. The storage-driven CO₂-EOR method aims to achieve net-zero or even negative CO₂ emissions by sequestering the major part of CO₂ emission in oil reservoirs while achieving the highest oil recovery. The potential for CO₂-EOR and storage has been assessed through site screening and numerical simulation methodologies, and the results indicate good EOR and storage potential. Carbon dioxide is being captured and compressed to a near liquid state and transported via pipeline for enhanced oil recovery (EOR). Aquifer-based **Carbon Capture and Storage (CCS)** using CO₂-EOR technology is also a very successful approach in reducing greenhouse gas emissions and achieving decarbonisation. The **Water Alternating Gas (WAG)** technique also enhances reservoir total recovery by improving the mobility ratio between oil and water. The **Carbonated Water Injection (CWI)** is more efficient than both gas injection and water flooding separately since the oil swelling can occur as a result of CO₂ moving from the water phase into the oil phase during CWI and the carbonated water or water that has been saturated with CO₂ can stay a single phase under reservoir conditions. **Active Carbonated Water Injection (ACWI)** incorporates surfactant and when combined with ACWI, CO₂ performed significantly better than when it was injected alone. Ammonia-based CO₂ collection is also one of the most commonly used sorption techniques. The low salinity water-alternating-CO₂ injection can further improve oil recovery. The Direct Air Capture (DAC) also can lower the global atmospheric CO₂ concentration in the atmosphere although it is difficult to implement.

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Osteochondroma of the Condyle: Report of A Case

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ABSTRACT

Mandibular condylar osteochondroma (OS) is a rare lesion although it is most common benign tumor of the axial skeleton. They are slow-growing tumors originating from the cortex of the bone resulting in facial asymmetry, temporomandibular dysfunction and occlusal derangement. We present an extremely rare case of condylar OS in a 35-year-old male patient who presented to our department with gradual deviation of the lower jaw, difficulty in opening the mouth and chewing the food for 2 years with clinicoradiological and pathological correlation. This case also highlights the importance of imaging in the diagnosis, treatment plan and follow-up of osteochondroma.

Keywords: Facial asymmetry, mandibular condyle, mandibular deviation, osteochondroma, temporomandibular joint

INTRODUCTION

Osteochondroma (OS) or solitary osteocartilagenous exostosis is an exophytic lesion that arises from the cortex of bone and is capped with cartilage. [1] It is a relatively common finding in the skeleton, occurring frequently in the metaphyseal region of the long bones. It is also found in the ribs, scapulae, clavicles, and vertebrae. [2] In the maxillofacial region, the occurrence of osteochondromas is infrequently reported and OS of the mandibular condyle



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is extremely unusual. [3] The majority of extra condylar osteochondromas occur on the coronoid process. However, cases have been reported in the posterior maxilla, maxillary sinus, zygomatic arch, mandibular body and symphysis. [4] This paper outlines the clinico-radiographic and histopathological features for diagnosis and appropriate treatment of condylar osteochondroma.

CASE REPORT

A 35-year-old male patient reported to the dental outpatient department with a chief complaint of deviation of the lower jaw towards the left side with difficulty in opening the mouth and chewing food for 2 years. Patient also experienced clicking & mild pain with left TMJ since 5 months. There was no history of trauma, infection in and around TMJ or ear and no similar complaints in the past. On extraoral examination facial asymmetry, left-sided deviation of the mandible (laterognathism to the left), an increase in volume in the region of the right temporomandibular joint and mandibular prognathism was noted. [Fig. 1a] Intraoral examination revealed restricted mouth opening and lateral jaw movements with unilateral cross bite (left side) and dental midline deviation by 1cm to the left reflecting an asymmetric prognathism. [Fig. 1b] Clinical features were indicative of condylar hyperplasia, hemifacial hypertrophy or a benign tumour of condyle or coronoid. Orthopantomogram showed an irregular radiopaque mass over the superior aspect of right condyle. [Fig. 2] Computed tomography (CT) scan with three-dimensional (3D) reconstruction showed a well-defined hyperdense bony mass with irregular and globular altered morphology in the right condylar region resulting in deformed and enlarged condylar head with anterior dislocation forming pseudoarticulation with the greater wing of sphenoid. [Fig. 3 and 4] From the clinical and radiographic findings, diagnosis of mandibular condylar tumour [osteochondroma, osteoma, chondroma, chondroblastoma and benign osteoblastoma] was given with differential diagnosis of unilateral condylar hyperplasia. The patient was treated with excision of the tumour mass with condylectomy under general anaesthesia. [Fig. 5] The histological sections revealed a bone lesion composed of mature bone without atypia with a chondral coating area also without atypia. The correlation with the clinical and radiological findings confirmed the diagnosis of osteochondroma of the mandibular condyle. Arch bar fixation with elastic traction for 3 weeks was done to guide the occlusion. The patient was under follow-up for 1 year with no recurrence.

DISCUSSION

OSs are common tumors of the long bones but are rare in the craniofacial region, the incidence of which is around 0.6%. With a peak in the fourth decade, the mean age of patient is 39.7 years, The male-to-female ratio is 1:1.28. In the facial skeleton, the coronoid process and the mandibular condyle are the most common sites of involvement. [5] Those involving the mandibular condylar region, are found most often on the medial aspect of the mandibular condyle at the site of attachment of the lateral pterygoid muscle (52%), followed by an anterior location (20%), but rarely on the lateral or superior positions (1%). They may appear as a solitary lesion (75%) or as multiple lesions (25%) [6]. There is still controversy as to its etiopathogenesis. Although the WHO defines it as a true neoplasm, according to some authors it is developmental or reparative in nature. Factors such as trauma and inflammation have been described in the literature as contributing to its development. [7,8] Osteochondromas are often slow growing. The presentation of condylar osteochondroma includes development of facial asymmetry, malocclusion, cross-bite on contra-lateral side and lateral open-bite on the affected side, deviation on opening, hypomobility, pain and clicking in TMJ. [2,9] All the above mentioned features were present in our case.

OS should be differentiated from unilateral condylar hyperplasia, and neoplasms like osteoma, chondroma, chondroblastoma and osteoblastoma. Considerable confusion exists between osteochondromas and unilateral condylar hyperplasia. However as the treatment plan differs for both these conditions, it is mandatory that clinico-pathological and radiological differentiation should be carried out between the two entities. Unilateral condylar hyperplasia is manifested clinically and radiographically as an enlarged condylar process where the characteristic condylar shape and proportions are better preserved whereas the osteochondroma is seen in 52% cases as a globular projection extending from the medial margins of the condylar head & generally create a more irregular appearance,



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with a bulbous or pedunculated growth pattern. The growth of the osteochondroma continues and progresses much longer even after the termination of skeletal growth while in the case of condylar hyperplasia, growth ceases. The definitive diagnosis is based on clinical, radiological and histological criteria.[9,10] Imaging plays a crucial role in the diagnosis, treatment plan and follow-up of osteochondroma. Panoramic radiographs reveal a radiopaque mass in the condyle region, which increases in density as the cartilage cap calcifies with age. They are a valuable screening modality which detect the lesions, but do not depict its extension.[3] CT is useful for determining the nature of the lesion, its continuity with the condyle's cortex and medulla, extent of the lesion and its relationship to the surrounding structures. [10] The thickness of the cartilage cap can be measured using an MRI, and the presence of the cartilage cap validates the diagnosis of osteochondroma. The bone scan can help to confirm the diagnosis by verifying greater radiotracer uptake as a result of enhanced osteoblastic activity, by Tc99 MDP. Furthermore, a whole-body single-photon emission CT scan eliminates the possibility of further osteochondromas in the bones.[11]

To propose a classification of condylar osteochondroma based on CT imaging, in a study of 61 cases of OS by Chen et al, two types of condylar osteochondroma were presented: type 1 (protruding expansion) in 50 patients (82.0%) and type 2 (globular expansion) in 11 patients (18.0%). Local resection was performed on patients with type 1 condylar osteochondroma. Subtotal condylectomy/total condylectomy using costochondral graft reconstruction with/without orthognathic surgeries was performed on patients with type 2 condylar osteochondroma. [12] The therapeutic choice for OS of condyle usually involves surgical treatments, which vary between partial or total condylectomy, with or without adjunctive orthognathic surgery. After tumour resection condylar reconstruction is also an option and may be performed by ascending reposition of the sagittal ramus or vertically divided, autogenous bone graft or using joint prosthesis [2,9].The overall recurrence rate of osteochondroma has been estimated to be around 2%, although it is considerably lower in the condylar region. To rule out recurrence, follow-up and the thickness of the cartilage cap are critical. [4] This case highlights the importance of imaging and histopathology for correct diagnosis and treatment planning of the tumour. In situations of suspected osteochondroma, a CT scan is highly recommended since it provides for a precise description of the lesion's boundary and interior structure. Total condylectomy followed by reconstruction is the treatment of choice depending on surface involvement.

CONCLUSION

Osteochondromas in the mandibular condyle are extremely rare, and when they occur, imaging plays a crucial role in the diagnosis, treatment plan and follow-up of osteochondroma. The main goal of treatment is to return function and improve facial aesthetics, with a technique that brings the least harm to the patient.

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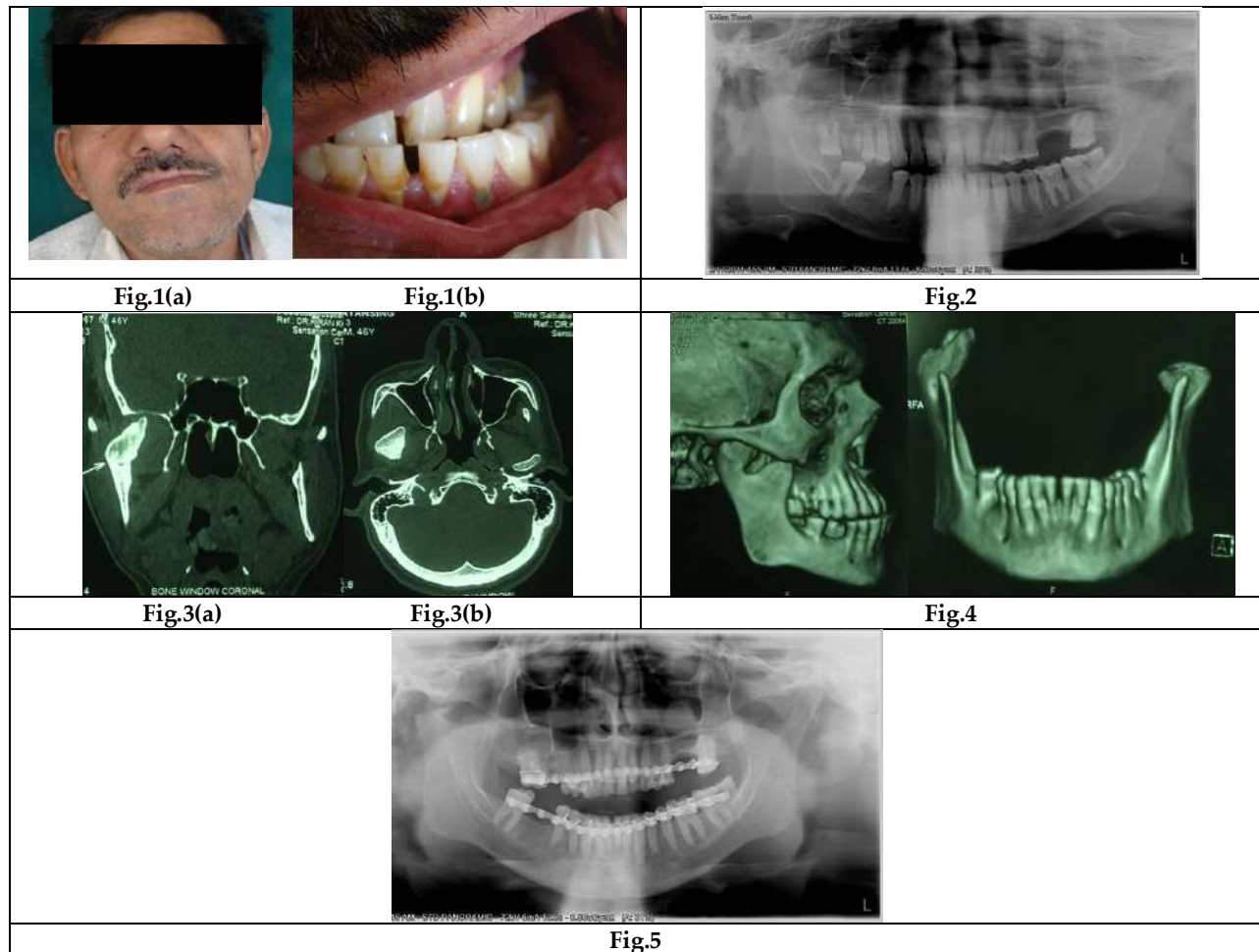
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RESEARCH ARTICLE

Influence of Home Environment and Personal Values on the Trait Emotional Intelligence of College Students

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ABSTRACT

The present paper intends to explore the relationship of the home environment and personal values with Trait Emotional Intelligence (Trait EI) among young adults. Given that an individual's family environment and the values they adhere to, play a substantial role in shaping their personality, it would be worthwhile to understand how these factors relate to their trait emotional intelligence and the extent to which they influence its development. For the stated objective, a purposive sampling method was undertaken to collect data from 300 college students (18-20 years). The participants were administered three standardized psychometric tools - the Twenty Item Value Inventory, Trait EI Questionnaire-Short Form, and the Family Environment Scale to assess the variables of values, emotional intelligence, and home environment respectively. The obtained data was analysed using correlation and regression analysis. It resulted in significant associations between the variables under study, and both personal values and home environment predicted the trait EI of young adults. The values of self-direction, benevolence, universalism, and hedonism to name a few, seem to correlate with and considerably influence ($R^2=0.22$) the trait EI of young adults, while the dimensions of home environment correlate with and greatly influence ($R^2=0.19$) the development of trait EI among the youth. The findings of the current study would assist parents and mental health professionals in understanding which aspects of home environment and personal values positively influence in enhancing Trait EI in young adults.

Keywords: Home environment, trait emotional intelligence, values, India, young adults.





INTRODUCTION

Emotional Intelligence (EI) as a concept has existed in the literature for over five decades now, although its origin lies in the concept of “Social Intelligence” put forth by E.L. Thorndike[1] in 1920. According to Mayer and Salovey (1997) [2], Emotional Intelligence can be defined as “The capacity to reason about emotions, and of emotions to enhance thinking”. Based on the different definitions of emotional intelligence (EI) and the types of measurements employed to assess them, three prevalent models of Emotional Intelligence exist, which include the Ability EI Model [2]; the Trait EI Model [3]; and the Mixed model.[4] Trait EI is defined as “A constellation of self-perceptions located at the lower levels of personality hierarchies.” [5] It is considered to be a part of our personality and can be regarded as the temperamental component of an individual’s emotional competence. Trait EI can be measured using self-report inventories, and comprises of four elements: a) Emotionality, b) Sociability, c) Well-being, and d) Self-control. Emotionality is defined as the extent to which an individual is able to express and perceive emotions. Sociability refers to the degree to which one is socially aware, along with the ability to affect others, and being assertive. Well-being, on the other hand, reflects the facets of happiness, optimism, and self-esteem related beliefs. The dimension of self-control is characterized by the facets of impulse control and stress management.

Family and home are the initial focal point of an individual while growing up, and they tend to regulate and integrate their actions as part of a community. The home environment in which a child lives with his parents is crucial for the social, physical, as well as psychological well-being of an individual. It is the first social institution that would have an immense impact on the child, and the groundwork created by the home environment would have its influence on the other interpersonal relationships that an individual would be a part of in the future, such as, at school, in college, as well as in personal and professional settings. [6] In the present research, home environment is defined as, “The quality and quantity of cognitive, emotional, and social support available to the child within home.” It influences the behaviour, values, and morals of adolescents and young adults, and acts as a safe harbour for them, providing the young adults with emotional and moral support in times of need.[7] Values are the concepts or beliefs that direct desirable individual behaviour across different situations and contexts. They shape our attitudes and actions and are placed in a hierarchical structure according to their relative importance in an individual’s life.[8][21][22] They generally develop over time and represent the characteristics of different societies and individuals. Essentially, there exists two kinds of values- a) Cultural values, which are broadly universal, and represent the goals and values that the members of a society as a whole strive to pursue and achieve; and, b) Personal values, which are broad and desirable goals that individuals hold at a subjective and private level. According to Kasai and Fakuda[9], personal values majorly develop and internalize during adolescence.

These values are also influenced by our social interactions, and according to Schwartz [10] can be divided into ten basic values, based on their underlying motivation. These include- i) Conformity, ii) Self-direction, iii) Stimulation, iv) Hedonism, v) Power, vi) Achievement, vii) Security, viii) Universalism, ix) Tradition, and x) Benevolence. Conformity as a value is related to the constriction of those actions, impulses, and inclinations, which may harm others or go against societal norms. Self-direction as a personal value is concerned with the presence of independence of thoughts as well as actions, which is expressed through choice-making, creation, and exploration of the environment by an individual on his own. Stimulation, on the other hand, refers to valuing novelty, and excitement, and facing challenges in life. Hedonism is the personal value that is largely connected to seeking pleasure and gratification for oneself, in various aspects of life. Power as a value is mostly cherished by individuals who need control and dominance over available resources, along with a sense of influence over other people. Achievement as a personal value refers to valuing one’s success in demonstrating competence in a particular field or activity. Valuing security in life refers to being concerned with the presence of harmony, safety, along with stability in personal life as well in the society in general. Universalism as a personal value is connected to having an understanding and appreciation for all people and for nature on a whole, and being interested in their welfare. Valuing tradition expresses an individual’s commitment and respect towards the customs and ideas provided by a given culture or religion. Finally, Benevolence refers to valuing the welfare of the society in general, and engaging in



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deeds which may preserve and enhance the state of living of other people on a general level. The more importance an individual ascribes to a particular value, the higher it is placed on the hierarchy pyramid. The more important the value, the more they influence the actions of individuals and act as guiding principles in their lives. Schwartz and Bilsky[8] posit that some values are more compatible with each other and are placed closely together on the circular continuum of values, whereas, the incongruent values are placed at opposite ends. Hence, the attainment of one value may conflict with the achievement of some other value.

Relationship of Home Environment and Personal Values with Trait EI

The young adult stage of development is crucial for the future of any individual since it is the time when the youth attain their individuality, including physical, psychological, and emotional independence. Nevertheless, the home and family relationships continue to serve as a secure base from which young adults can seek solace and gain confidence and strength to continue growing and moving forward[7]. The feedback that parents provide to their children acts as social mirrors for young adults and influences the way they look at themselves; their self-image and judgments. [11][12] The higher the cohesion among family members and the family functioning in general, the higher the trait EI of the youth within the family. [13] Higher Trait emotional intelligence (Trait EI) has been associated with increase in level of happiness ^[14] and reduced levels of stress and anxiety among young adults.[15] Additionally, it is positively associated with enhanced academic performance, job satisfaction, and improved peer relations in the youth.[16][17] Consequently, presence of greater levels of trait EI is a desirable attribute, especially among young adults. Another study conducted by Naik and Shukla [18] also provided similar results, suggesting that the home environment is an important factor that impacts the development of both social and emotional intelligence among adolescents. Hence, a positive home atmosphere, wherein the parents foster the emotional skills of their children while enabling them to make informed and responsible choices, will lead to improved emotional competence.

In a study conducted by Nguyen et al.[19] on Vietnamese adolescents, it was concluded that parental warmth and support had a positive impact on the trait EI among adolescents, while authoritative parenting and over protectiveness had a negative impact. Argyriou et al. [20] inferred that a positive association exists between authoritative parenting and the development of trait EI in young adults, while authoritarian style of parenting had a negative relationship with trait emotional intelligence. According to their findings, along with the parenting styles, the “emotional climate” of the home also plays a major role in shaping the trait EI of the youth. On the other hand, research concerning the relationship of personal values with trait emotional intelligence among young adults and how values influence the development of trait EI is particularly scarce, especially in the Indian context. However, it has also been noted that children raised in environments with positive family functioning and values demonstrated higher emotional intelligence and were less inclined to indulge in aggressive behaviours. [21]

In a recent study conducted by Jacobs and Wollny[22] on German young adults, significant positive associations were found between the global trait EI, its four components (Emotionality, self-control, sociability, and well-being), and higher-order personal values. Personal values act as guiding forces in our lives, therefore, it would be worthwhile to understand which of these are crucial for fostering trait EI of young adults, provided that there exists a correlation between these variables. The young adult stage of development is one of the most important stages in our lives, owing to the growing level of independence and individual thinking and decision-making it brings with itself. Hence, it would be valuable to study the relationship of the home environment as well as personal values with the trait EI. Keeping this in mind, the present study aimed to understand the relationship of Trait Emotional Intelligence (Trait EI) with the Home Environment and Personal Values among college students, and whether these two factors have any influence on the trait EI of college-going young adults. Based on the review of previous research it was hypothesized that trait emotional intelligence would have a significant relationship with home environment as well as personal values. Furthermore, these two would also be the predictors of Trait EI in young college-going students.





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MATERIALS AND METHODS

Sampling

For the present research, the required data was accumulated through self-report questionnaires, which were circulated through Google Forms. The participants for the research study included 300 college students in the age group of 18-20 years, residing in India. They were all undergraduate college students, consisting of 127 male students (42.3%) and 173 female students (57.7%) respectively. The mean age of the participants in the study was 19.59 years. They were administered a battery of three standardized psychological tests. Purposive sampling was used for data collection.

Tools Used

Family Environment Scale (FES)

The Family Environment Scale (FES) is a 69-item inventory developed by Bhatia and Chadha[6] in 1993. It is used to measure the social as well as environmental attributes of families. It broadly measures three dimensions of the home environment, which include, a) Relationship, b) Personal Growth, and c) System-maintenance. The total score for each sub-scale is calculated by adding the scores on all the items corresponding to the particular sub-scale, and its interpretation is based on standardized norms for each dimension. The scale has adequate split-half reliability, with reliability coefficients ranging from 0.48 to 0.92. In addition, the Family Environment Scale has a significant face as well as content validity.

Twenty Item Values Inventory (TwIVI)

TwIVI was developed by Schwartz et al.[23] in 2016 and it is the brief version of the Portrait Value Questionnaire (PVQ-40) created by Shalom Schwartz (2003). The scale consists of 20 items, which intends to measure the ten personal values given by Schwartz. The values include- i) Conformity, ii) Tradition, iii) Benevolence, iv) Universalism, v) Hedonism, vi) Self-direction, vii) Power, viii) Stimulation, ix) Security, and lastly, x) Achievement. The scale contains items that provide verbal portraits of individuals, and the respondent has to choose the response from 1 ("Not at all like me") to 6 ("Very much like me") based on how much they relate to the statement. The scale has been found to have adequate test-retest reliability and content validity.

Trait Emotional Intelligence Questionnaire-Short Form (TEIQue-SF)

TEIQue-SF was developed in 2006[24]. It consists of 30 items and is a self-report questionnaire, which aims to measure the global Trait EI. The questionnaire also measures the four factors of trait EI, which include- a) Emotionality, b) Self-control, c) Sociability, and d) Well-being. It is a 7-point Likert-type scale, where the respondents are required to choose the option most suitable to them, from completely disagree to completely agree. The global trait EI is measured by calculating the average of all the items on the scale. TEI Que-SF also has sufficient internal consistency reliability ($\alpha = 0.83$), as well as adequate temporal validity.

DATA ANALYSIS

The obtained data was scored and analysed using SPSS version 26. Pearson correlation and regression analysis were computed along with the descriptive statistics for the data analysis.

RESULTS AND DISCUSSION

The current research intended to find out role and relationship of personal values and the home environment with Trait EI in the young college-going adults. Secondly, if personal values and the home environment in which the young adults live predict trait EI. The obtained results do indicate the influence of values and home environment on



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the Trait EI of the young students. The descriptive statistics presented in Table 1 indicate that on the variable of Trait EI, the female sample has higher mean scores ($M=4.44$) as compared to the male sample ($M=4.32$). This indicates that the females are more emotionally intelligent than the males of this sample. Previous researches conducted in order to understand the gender differences in trait EI have found varying results; while some studies are in line with the findings of the present study,[25] other studies obtained opposing results.[26][27] These variations might arise from the fact that gender alone does not influence emotional intelligence- numerous related factors, such as age, socio-economic status, cultural influences, as well as home environment, play a role in determining the trait EI of an individual. [28][29] Among the personal values, the value of universalism has the highest mean ($M=4.37$) for the total sample, followed by benevolence ($M=4.26$), self-direction($M=4.25$), and hedonism($M=4.15$). Individually, the female sample again displays higher means for all values, as compared to the male sample, as can be seen in the mean scores of values including- achievement (female $M= 4.21$, male $M= 3.98$), universalism (female $M= 4.46$, male $M= 4.25$), self-direction (female $M= 4.34$, male $M= 4.12$) etc. This indicates that females value achievement more than the males. In present context it can be said that females have also become more aware and concerned about their self-growth and self-identity. Previous studies also indicate similar results.[25][29]

On the variable of home environment, the means for the total sample range from 41.57 for the dimension of cohesion, to 6.72 for organization. Again, the female sample present higher means as compared to the male sample, on dimensions such as that of cohesion (female $M= 42.10$, male $M=40.86$), expressiveness (female $M= 28.71$, male $M= 27.66$), and Independence (female $M= 29.01$, male $M= 28.02$). Females in the current sample also perceive their home environment to be more controlling ($M=12.60$) as compared to males ($M=12.42$). These results are in accordance with the existing literature,[30][31]and may arise due to imbedded socio-cultural factors, in a collectivistic nation such as India, where higher importance is placed on family values, interdependence, harmony and conflict avoidance. According to the obtained results in Table 2, all the personal values, except for tradition, show a significant, positive, weak to moderate correlation with the global trait emotional intelligence (global trait EI) among young adults. The correlations range from 0.189 to 0.38 for the total sample and are significant at either 0.05 or 0.01 level. Within the male sample, except for the values of tradition and achievement, all the other personal values demonstrate significant, positive, weak to moderate correlations with the global trait EI among young adults. The correlations range from 0.239 to 0.397, significant at either 0.05 or 0.01 level. Within the female sample, the personal value of tradition shows a significant, negative, weak association (-0.15 , $p<0.05$) with the global trait EI. All the other values are positively correlated with the global trait EI of female young adults. The four factors of trait EI, namely, well-being, self-control, emotionality, and sociability are also significantly correlated with the different personal values and show weak to moderate positive correlation with these variables.

This indicates that individual values such as conformity, universalism, hedonism, and stimulation to name a few, are positively related to the trait EI of young adults, and is in line with the previous research conducted in this regard.[22] Table 3 displays the results of bivariate correlational analysis between the dimensions of home environment and trait EI of young college-going adults, for the male, female, and the total sample. According to the results, all the dimensions of home environment have a significant, weak to moderate, positive association with the global trait EI of young college-going adults., such as active-recreational orientation ($r=.371$), organization ($r=.361$), and cohesion ($r=.341$).All the correlations are significant at either 0.05 or 0.01 level. Similar results can be seen for the male as well as the female sample respectively. The obtained results indicate that the perceived level of cohesion, freedom to express one's thoughts and emotions, acceptance & care provided, and recreational activities undertaken within home will positively influence the trait EI of young college students; greater levels of independence with moderated control, unconditional acceptance, and organization provided at home will lead to greater trait EI. The four factors of trait EI are also significantly positively correlated with the dimensions of home environment, while having weak to moderate correlations with these variables. The positive correlations found between home environment and trait emotional intelligence of young adults are in accordance with the available researches.[13][18][19][20] Table 4 provides the model summary for the regression analysis carried out to find out whether personal values tend to predict the trait emotional intelligence of young adults. The recorded R^2 value is 0.220, which signifies that the different personal values, as an independent predictor variable, can explain 22% of the



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variation in trait emotional intelligence of young college-going adults. Hence, this indicates that personal values indeed significantly influence the development of trait EI of college-going students. Table 5 presents the coefficients of the different personal values, and whether their effect on the dependent variable, i.e., global trait emotional intelligence of young college students, is significant or not. According to the results, the values of Tradition ($t = -2.51$; $p < .05$), Self-direction ($t = 2.16$; $p < .05$), Hedonism ($t = 2.85$; $p < .05$), Achievement ($t = -1.89$; $p < .05$), and Power ($t = 2.14$; $p < .05$) show a significant effect on the trait EI. Therefore, it can be concluded that the level of importance the young adults place on valuing their customs or religion, having an independent thought process, while also seeking personal gratification, as well as a sense of power and achievement, has a significant impact on their trait emotional intelligence. Since individual values develop over time since childhood, and are greatly affected by the culture, environment, and the family as well as the peers one surrounds themselves with, hence, it is crucial for family members as well as teachers and mentors to focus on the values adolescents and the youth place importance on, since they considerably influence their trait EI, and hence, have an influence on their personalities.

Table 6 offers the model summary for the regression analysis conducted to explore whether the dimensions of home environment predict the trait emotional intelligence (trait EI) of college students, thus, having a significant impact on its development. According to the obtained results, the recorded R^2 value is 0.180, which suggests that home environment as an independent predictor variable, explains 18% of the variance in the trait emotional intelligence of young college-going adults. Hence, as hypothesized the home environment significantly influences the Trait Emotional Intelligence of college-going students. Consequently, it is imperative that parents understand the importance of their parenting style and the home environment on the trait EI development of their children. The kind of bonding and relationships the young adults experience in their homes will directly influence the manner in which they will form and carry out interpersonal relationships in the future.

Table 7 presents the coefficients for the dimensions of home environment, and whether they significantly predict the trait emotional intelligence of college students. According to the results, the dimensions of active-recreational orientation and organization within the home environment shows a significant effect on the trait EI of the young adult sample. They have a t value of 2.05 ($p < .05$), and 2.70 ($p < .05$) respectively. The other dimensions of home environment do not show a significant impact on the trait EI, within the given sample. Therefore, it can be assumed that the extent to which the family takes part in social and recreational activities, while having a clear organizational structure in planning family events and individual responsibilities, significantly influences the development of trait EI of young adults. It would help the young adults learn and develop social and interpersonal skills, and ways to regulate their emotions while participating in a group setting.

CONCLUSION

The findings of the present study conclude that both the variables- personal values as well as the dimensions of home environment significantly relate to and predict the trait emotional intelligence of young college students. Personal values seem to influence and predict trait EI a little more, as compared to the home environment. This might be due to the fact that trait EI is part of our personality, and personal values are subjectively held by individuals and form a crucial aspect of their identity, including the manner in which they deal with and respond to different people and situations. The values of benevolence, self-direction, hedonism, universalism, and self-direction significantly impacts the trait EI of young adults, while the level of organization and availability of recreational activities at home tends to influence the trait EI of college-students, with regards to the home environment.

LIMITATIONS OF THE STUDY

These findings would add notably to the available literature, since the current repertoire of research related to the studied variables is limited. The research has a few limitations as well, thus, generating the need for further research in order to make more accurate generalizations. The sample undertaken in the present study, albeit adequate, can be increased to include a varied demographic, in terms of socio-economic background, culture, age, and gender. The





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sample belonged to a few cities of India, hence, a greater representation by involving the young adults from other cities and states would be helpful in order to acquire a clearer picture. In addition, since the questionnaire consisted of self-report assessments, there is a possibility that the participants may have manipulated their responses. Thus, an even more balanced, heterogenous sample would help researchers in attaining further improved conclusions.

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Table 1: The Mean (M) and Standard Deviation (Sd) for the Young Adult Sample on The Variables of Trait Emotional Intelligence, Personal Values, and Home Environment.

Variable	Male (n=127)		Female (n=173)		Total (N=300)	
	M	SD	M	SD	M	SD
Trait EI						
Well-being	4.42	1.06	4.69	1.04	4.57	1.06
Self-Control	4.18	0.855	4.25	0.84	4.22	0.84
Emotionality	4.42	0.89	4.45	0.92	4.44	0.90
Sociability	4.22	0.87	4.30	0.85	4.26	0.86
Global Trait EI	4.32	0.78	4.44	0.73	4.39	0.75
Personal Values						
Conformity	3.94	1.23	4.02	1.19	3.99	1.20





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Tradition	3.28	1.31	3.26	1.18	3.27	1.23
Benevolence	4.20	1.15	4.31	1.13	4.26	1.14
Universalism	4.25	1.25	4.46	1.17	4.37	1.20
Self-direction	4.12	1.26	4.34	1.10	4.25	1.18
Stimulation	3.96	1.28	4.09	1.05	4.04	1.15
Hedonism	4.06	1.25	4.22	1.06	4.15	1.15
Achievement	3.98	1.26	4.21	1.04	4.11	1.14
Power	3.67	1.17	3.69	1.08	3.69	1.12
Security	3.99	1.16	4.19	1.09	4.11	1.12
Home Environment						
Cohesion	40.86	8.16	42.10	8.65	41.57	8.46
Expressiveness	27.66	5.30	28.71	5.76	28.26	5.59
Conflict	37.78	6.05	38.31	6.23	38.08	6.15
Acceptance & Caring	38.08	6.82	38.68	7.47	38.43	7.19
Independence	28.02	4.34	29.01	4.93	28.59	4.71
Active-Recreational Orientation	25.56	4.99	25.64	5.54	25.61	5.31
Organization	6.52	1.66	6.87	1.93	6.72	1.83
Control	12.42	2.54	12.60	2.65	12.52	2.60

Table 2: Bivariate Correlations between Persona Values and Trait Emotional Intelligence for the male, female, and the total sample.

Personal Values	Trait Emotional Intelligence														
	Well-being			Self-control			Emotionality			Sociability			Global Trait EI		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Conformity	.430**	.243**	.325**	.315**	.076	.181**	.047	.135	.098	.248**	.045	.134*	.300**	.156*	.222**
Tradition	.294**	-.121	.065	.096	-.038	.022	-.150	-.171*	-.162**	.038	-.127	-.053	.108	-.157*	-.035
Benevolence	.416**	.334**	.372**	.322**	.075	.182**	.202**	.366**	.298**	.259**	.121	.182**	.347**	.313**	.330**
Universalism	.411**	.346**	.381**	.293**	.216**	.252**	.223**	.313**	.274**	.208*	.133	.170**	.341**	.337**	.344**
Self-direction	.443**	.356**	.402**	.272**	.181*	.225**	.292**	.355**	.326**	.336**	.146	.236**	.397**	.356**	.380**
Stimulation	.410**	.338**	.374**	.171	.112	.141*	.114	.232**	.177**	.173	.105	.139*	.254**	.283**	.272**
Hedonism	.455**	.445**	.453**	.267**	.195*	.230**	.253**	.296**	.276**	.321**	.188*	.252**	.366**	.371**	.372**
Achievement	.241**	.337**	.300**	.037	.072	.059	-.043	.212**	.095	.060	.152*	.112	.092	.266**	.189**
Power	.305**	.221**	.257**	.148	.120	.133**	.057	.090	.076	.315**	.154*	.226**	.239**	.191*	.213**
Security	.385**	.267**	.326**	.309**	.034	.158**	.184*	.289**	.244*	.228**	.061	.138*	.324**	.234**	.280**

NOTE: **=p<0.01. * = p< 0.05. M= Male, F= Female, T= Total sample





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Table 3: Bivariate Correlations between the dimensions of Home Environment and Trait Emotional Intelligence for the male, female, and the total sample.

Home environment Dimensions	Trait Emotional Intelligence														
	Well-being			Self-control			Emotionality			Sociability			Global Trait EI		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Cohesion	.213*	.318**	.281**	.169	.248**	.217**	.437**	.328**	.372**	.221*	.181*	.200**	.325**	.347**	.341**
Expressiveness	.271**	.257**	.271**	.270**	.173*	.215**	.459**	.197**	.301**	.308**	.152*	.218**	.394**	.245**	.311**
Conflict	.223*	.289**	.264**	.137	.148	.145**	.344**	.237**	.281**	.268**	.114	.180**	.299**	.259**	.278**
Acceptance & Caring	.185*	.312**	.263**	.146	.245**	.206**	.414**	.307**	.349**	.198*	.162*	.178**	.293**	.337**	.320**
Independence	.200*	.342**	.295**	.119	.194*	.167**	.339**	.231**	.273**	.246**	.158*	.196**	.261**	.297**	.287**
Active-recreational Orientation	.197*	.352**	.288**	.169	.294**	.244**	.408**	.365**	.381**	.234**	.246**	.241**	.323**	.407**	.371**
Organization	.168	.381**	.306**	.133	.238**	.199**	.364**	.353**	.356**	.220*	.315**	.280**	.273**	.415**	.361**
Control	.140	.292**	.231**	.056	.326**	.215**	.296**	.288**	.292**	.083	.203**	.155**	.204*	.336**	.281**

NOTE: **= $p < 0.01$, * = $p < 0.05$. M= Male, F= Female, T= Total sample

Table 4: Model Summary for Liner Regression Analysis to predict the effect of Personal Values on the Trait Emotional Intelligence of college-going young adults.

Model Summary				
Model	R	R ²	Adj. R ²	St. Error of the Estimate
1	.459	.220	.193	.680

- Predictors: Security, Tradition, Stimulation, Power, Conformity, Achievement, Hedonism, Universalism, Self-direction, Benevolence
- Dependent Variable: Global Trait Intelligence

Table 5: Personal Values coefficients to predict Trait Emotional Intelligence of college-going students.

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	3.11	.201		15.44	.000
Conformity	.016	.048	.026	.334	.739
Tradition	-.092	.037	-.151	-2.513	.013
Benevolence	.043	.057	.065	.751	.453
Universalism	.059	.052	.095	1.146	.253
Self-Direction	.117	.054	.183	2.169	.031
Stimulation	-.055	.055	-.084	-.994	.321
Hedonism	.143	.050	.218	2.851	.005
Achievement	-.089	.047	-.135	-1.892	.059
Power	.092	.043	.136	2.142	.033
Security	.056	.049	.084	1.155	.249
Dependent Variable: Global Trait Emotional Intelligence (Global trait EI)					





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Table 6: Model Summary for Liner Regression Analysis to predict the effect of Home Environment on the Trait Emotional Intelligence of college-going young adults.

Model Summary				
Model	R	R ²	Adj. R ²	St. Error of the Estimate
1	4.24	.180	.157	.69

- a. Predictors: Control, Active-recreational Orientation, Independence, Conflict, Cohesion, Expressiveness, Organization, Acceptance & Caring
- b. Dependent Variable: Global Trait Intelligence

Table 7: Home environment coefficients to predict Trait Emotional Intelligence of college-going students.

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.72	.299		9.09	.000
Cohesion	.003	.011	.030	.253	.801
Expressiveness	.012	.013	.091	.925	.356
Conflict	-.003	.010	-.024	-.304	.761
Acceptance & Caring	-.003	.012	-.030	-.270	.787
Independence	-.002	.013	-.011	-.133	.894
Active-recreational orientation	.026	.013	.182	2.05	.041
Organization	.082	.030	.198	2.70	.007
Control	.023	.019	.078	1.195	.233

Dependent Variable: Global Trait Emotional Intelligence (Global trait EI)





Deportation of Reactive Nitrogen Compound by Biological Method in Wastewater Treatment Plant

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ABSTRACT

High amounts of reactive nitrogen compounds in wastewater constitute a major threat to the environment and to public health. New biological techniques have been developed to address this problem because conventional wastewater treatment technologies are ineffective in eliminating these chemicals. The process of eliminating reactive nitrogen compounds from wastewater using biological treatment techniques in wastewater treatment plants is summarized in this abstract. Microorganisms are used in the biological treatment of wastewater to degrade and eliminate impurities from the water. To be more precise, nitrifying bacteria are utilized to change reactive nitrogen substances like ammonium and nitrite into nitrate, which can then be eliminated through denitrification. A particular set of environmental factors, such as the existence of dissolved oxygen and a suitable pH level, are necessary for this process. Moving bed biofilm reactors, sequencing batch reactors, and membrane bioreactors are just a few of the technologies that have been created to help with the biological removal of reactive nitrogen compounds. Depending on the particular application and wastewater properties, these systems offer a variety of benefits and drawbacks. Overall, eliminating reactive nitrogen compounds from wastewater by biological treatment is a promising strategy. The quality of the receiving water bodies can be refined, and the dangers to the environment and human health connected with the discharge of these substances can be greatly minimized.

Keywords: Waste water, Nitrogen, Anammox, Nitrification, Denitrification



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INTRODUCTION

All living cells contain proteins and nucleic acids, both of which are structurally dependent on nitrogen. Even though this element is essential for life, living things can only use it in the form which are reactive. The most prevalent element in the atmosphere, molecular nitrogen (N_2), makes up 78% of all atmospheric gases. Since relatively few organisms can break the triple bond that exists between the two nitrogen atoms in N_2 , most species are unable to use it. Hence, in order to maintain most life, this plentiful non-reactive form of nitrogen must be changed into usable or "reactive" nitrogen forms (such as NH_3 or NO_3). [1] Most of the fixed nitrogen is produced biologically by a tiny batch of prokaryotes known as diazotrophs, which use a specific enzyme route to convert N_2 to nitrogen trihydride. A range of these prokaryotes associate symbiotically in the company of both flora and fauna, such as termites and lamellibranch, whilst others roam freely in both ecological systems on land and in water. Fulmination, ignition, industrial fixation, and burning of biomass are some non-biological methods of Azote fixation. Nitric oxide, a different type of reactive nitrogen, is produced when nitrogen gas is oxidized due to the intense heat and pressure coupled with internal combustible engines in cars. Reactive nitrogen can also be produced by burning biomass for fuel or by clearing land for agriculture.[2] Nitrogen (N_2) that was previously non-reactive can now be absorbed by plant roots and integrated into proteins and RNA/DNA. Majority of the plants require nitrifying bacteria to transform ammonia produced by nitrogen-fixing prokaryotes into nitrate before they can use it. Nitrifying bacteria are a different class of microorganisms from nitrifying prokaryotes.

Most of the time, two groups of aerobic bacteria must cooperate in order to metabolize ammonium to nitrate during nitrification. Nitrite-oxidizing bacteria next convert NO_2 to NO_3 , which is followed by ammonia-oxidizing bacteria converting NH_3 to NO_2 . [5] All life forms probably pass away and are broken down by bacteria that ferment organic nitrogen sources into ammonium. Sources of reactive inorganic nitrogen can now reenter the nitrogen cycle by a process known as Mineralization. After being transformed back into molecular nitrogen (N_2) via anaerobic ammonium oxidation or denitrification, reactive nitrogen can also reach the atmosphere (anammox). [3] In order to protect the environment, wastewater treatment facilities, or WWTPs are required. This is because the volume of anthropogenically generated polluting nitrogen sources and wastewater has increased significantly. The nitrification-denitrification process, which has been extensively used to treat ammonium-rich wastewater, is the nitrogen cycle process that is most important for removing nitrogen.[7] During this process, ammonia is first converted to nitrate via the production of nitrite under aerobic conditions, which are crucial, and then the oxidized nitrate is anaerobically rehabilitated to nitrogen gas in the presence of organic carbons as one of the sources of electrons. However, due to the high oxygen demand for complete nitrification that has been calculated over the years and up to the present, the requirement for a peripheral carbon source for heterotrophic denitrifiers, the high generation of sludge, and the high emissions of greenhouse gases (N_2O), it is parsimoniously expensive. The anammox process has been acknowledged as a well-organized and cost-effective alternative to the nitrification-denitrification process.

Anammox is an alternative for nitrogen removal by directly transforming ammonium compound and nitrite molecule to nitrogen gas.[20] In wastewater treatment facilities (WWTP), one of the crucial processes is biological nitrogen removal, or BNR. Nitrification and denitrification are the two phases that make up the traditional BNR process, and denitrification is one of the most important. Two separate reactions contribute to nitrification. Physiologically unique clades of microorganisms that are present all around the world catalyse these two sub reactions that are produced. The biogeochemical process of ammonia being oxidised into nitrite by ammonia-oxidizing bacteria (AOB) is irradiated by study on the genera *Nitrosospira* and *Nitrosomonas*. After that, nitrite-oxidizing bacteria (NOB) continue to oxidise nitrite into nitrate, progressing the biochemical process as shown by research on the genera *Nitrosospira* and *Nitrobacter*. [9] Heterotrophic bacteria like *Pseudomonas stutzeri* and *Paracoccus denitrificans*, which are extremely dependent on abundant organic carbon sources as electron donors to convert the rising concentration of nitrogen oxides to nitrogen gas, are the primary initiators of the denitrification process. The traditional method of biological nitrogen removal has evolved intensive in terms of energy because of the





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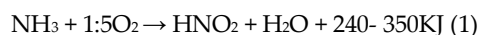
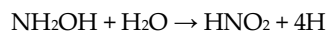
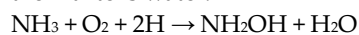
requirement of oxygen supply in nitrification and the requirement of organic matter for denitrification.[8]The condensed oxygen content does not agree with the selective suppression of NOB, Though the nitrification and denitrification procedure are designed to reduce organic carbon and oxygen consumption by 40% and 25% each, respectively *Nitrosomonas europaea* differs from other genera of *Nitrospira* in that they have unexpectedly lower half saturation constants (also known as K_m) values for dissolved oxygen (DO), which allows them to thrive at low DO concentrations. The ammonia oxidation rate by AOB would be reduced if dissolved oxygen (DO) was further decreased to wash out the nitrogen molecule by restricting the electron flow and the electron acceptor to the ammonia monooxygenase (AMO).[14] While there are numerous methods for recovering nitrogen from waste water systems within a circular economy paradigm, there are other industrial emancipations for which nitrogen recovery has been difficult in the past and continues to be difficult now. Thus, it is mandated to eliminate nitrogenous substances from the waste treatment process using inventive and practical technologies. The goal of the contemporaneous assessment is to examine the major obstacles that need to be overcome in order to combine these emerging biotechnologies in order to achieve nitrogen removal from aqueous and gaseous wastes.[15]

BIOLOGICAL TRANSFORMATIONS OF NITROGEN

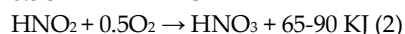
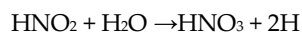
In urban and agricultural sewage, nitrogen is typically found as organic nitrogen or ammonia. The cycle illustrates what happens to this nitrogen in a wastewater treatment facility. The strong solid traces indicate that the reaction and biomass production are connected (anabolism). Firstly, by nitrifying ammonia to produce nitrite or nitrate, which is then reduced via denitrification to produce nitrogen gas, ammonia is naturally removed. In conclusion, the task of a sewage treatment facility is to transform influent that is nitrogen-rich into nitrogenous "smooth" effluent, with stable sludge produced as a byproduct of the process in general (Table 1). Many nitrification and denitrification paths are feasible, in light of the environmental factors present in the treatment plant, as seen in ways of nitrogen cycling (Figure 1).

NITRIFICATION

Nitrogenous molecules that have been reduced, such as azane, hydroxyammonia and dioxidonitrate(1-), are aerobically transformed into more oxidised compounds. Azane is the true substrate for nitrifiers rather than the ammonium ion because it is much simpler to transfer the required and important membrane with the neutral ammonia molecule.[26]Despite the fact that heterotrophic nitrification has been proposed[23], autotrophic nitrification still dominates in wastewater treatment facilities. In different ranges, chemolithoautotrophic bacteria convert ammonia to nitrate. *Nitrosospira*, *Nitrosovibri*, *Nitrosomonas*, and *Nitrosococcus* are responsible for converting ammonia to nitrite, whereas *Nitrobacter*, *Nitrospira*, and *Nitrococcus* species are responsible for oxidising nitrite.[4-7] Ammonium monooxygenase serves as the catalyst in the initial oxidation step of this oxidation process, which converts ammonia to hydroxylamine. The hydroxylamine oxidoreductase, which also provides the reducing agents needed for step one, catalyses the second, strength-building process. The source of the second oxygen atom within the nitrite is water.



The nitrite oxidizers are then used to convert nitrite to nitrate, and nitrite oxido reductase catalyses this step.



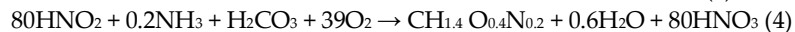
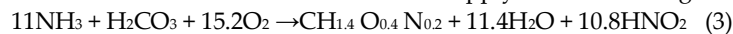
To produce the energy required for growth, reducing retailers [H] generated from the oxidation of nitrite and ammonia are oxidised inside microorganism's respiratory system (Table 2). The fact that oxygen serves as the respiratory chains' last electron acceptor of oxidizers of both nitrite and ammonia highlights how important oxygen is for autotrophic nitrogen fixation (Figure 2). The Calvin cycle is used to accomplish this carbon fixation, which consumes about 80% of the energy produced by catabolism.[18]



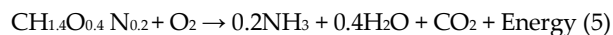


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One can deduce the typical nitrification stoichiometry by presuming a mean microorganism composition of $\text{CH}_{1.4}\text{O}_{0.4}\text{N}_{0.2}$ with ammonia as the handiest supply of mobile nitrogen:



Bacteria may survive in the lack of a substrate by engaging in endogenous respiration, which is both plentiful and beneficial.



It is obvious from the stoichiometry above that nitrification requires a significant amount of oxygen, and that this process would cause the pH of the effluent to decrease.

DENITRIFICATION

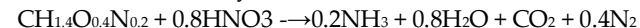
The rate at which oxidized nitrogenous substances transform into nitrogen gas is known as Denitrification. The genera *Pseudomonas*, *Alcaligenes*, and *Paracoccus* are common denitrifiers. Nitrate reduction is implemented in ranges. Prior to (NAD(P)H) completing the reduction to nitrogen gasoline, nitrate reductase catalyzes the reduction to nitrite (Figure 3). Ammonia, sulphide, and hydrogen are examples of natural and inorganic ions that are potential electron donors for denitrification.[16]

ORGANIC FORM OF DENITRIFICATION

Denitrification with a natural material is based on facultative heterotrophs that can use nitrite and/or nitrate as the final electron acceptors in their respiratory system. Nitrite may always be reduced by any microbe that can reduce nitrate. [19] Hence, for the sake of simplicity, it is occasionally considered to have a solitary denitrifier group that has both nitrite and nitrate reduction capabilities. The origin of cellular carbon is organic carbon. For instance, when acetate is used as an electrical source and ammonia is used as a source of cellular nitrogen, Anabolic and catabolic stoichiometry is as follows



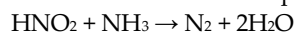
Since nitrate serves as the primary electron acceptor in endogenous metabolism, the stoichiometry of this process can be calculated similarly to that of nitrification



When only one class of denitrifiers is taken into account, the equation can be used to calculate the actual growth yield as 0.40 or 0.43 gm of biomass per gm of COD. The sludge output from this type of heterotrophic denitrification is superior to that from nitrification because denitrification produces alkalinity, which raises the pH of the wastewater. In addition to extracellular substrates, organic polymers found inside cells can also be used for denitrification. In order to denitrify water, combined a denitrifying microorganism with poly-b-hydroxybutyric (PHB) acid in a biopolymeric matrix. PHB's application in the denitrification process allows for the simultaneous removal of phosphate and nitrogen from sewage.

INORGANIC FORM OF DENITRIFICATION:

Due to the electron donor, sulphide, hydrogen, and ammonia can all be used in autotrophic denitrification. Typically, wastewater contains insufficient amounts of hydrogen and sulphide to serve as important electron donors. For the conversion of dioxidonitrate(1-) to Azate, ammonia can act as an electron donor [25]. Nitrite is used to oxidize ammonia in anaerobic (or, more precisely, under circumstances of anoxia or nitrification) with equal contributions from both species to the azate concentration of the resultant nitrogen gas.



Since that nitrogen in gaseous form is produced during the reaction, this process—known as anaerobic ammonia oxidation (famously known as Anammox)—which is considered to be denitrification as opposed to nitrification. Anammox-causing bacteria are autotrophic, and the carbon in their cells comes from inorganic sources.





CONCLUSION

The abolition of Azane from ammonia in the wastewater treatment flora, which has been shown to be the most crucial step, is controlled by two mechanisms: A process for converting nitrous oxide into gasoline utilising nitrification and denitrification-related processes. The other mechanism being an essential route called the assimilatory pathway that leads to the formation of bacterial biomass. Most often, the major running expense of any wastewater treatment facility is the creation of sludge and its eventual eradication. In a downstream sludge digester, endogenous respiratory conditions are frequently encouraged to reduce sludge generation. Sludge digestion, on the other hand, makes sure that any assimilation of nitrogen is returned to the waste water as soluble components. Hence, the primary goal of biological nitrogen elimination needs to be nitrogen removal rather than sludge creation. Anaerobic oxidation of ammonia (i.e., the Anammox technique) and heterotrophic denitrification is used in conjunction with autotrophic nitrification. Theoretically, Anammox promises to offer simultaneous nitrite and ammonia removal. Anammox, should be utilized to turn ammonia into Azote without aeration or a natural carbon supply if partial influent ammonia is first converted to dioxidonitrate(1-)for ammonia removal from wastewater. An extensive start-up phase would be required for a comprehensive Anammox plant owing to the exceedingly slow development and 29-day doubling time of the bacteria that cause Anammox(Van de Graaf, 1997).[25]Also, because anammox microbes grow slowly in organic-rich wastewater, they can easily be replaced with heterotrophs that consume organic matter. Nevertheless, it has been demonstrated that the use of Anammox is practical under the right operating conditions. For instance, Anammox has proven to be a great option for eliminating ammonia from digester effluent at relatively high temperatures (25–35 °C, to sell a better boom charge) and with a low natural awareness^[24]. The primary method for removing organic nitrogen from wastewater is autotrophic nitrification, which is observed via heterotrophic denitrification in standard wastewater treatment circumstances (10–20 °C and with the inclusion of organic fabric).From the perspective of pH manipulation, denitrification produces alkalinity, whereas nitrification consumes it. The need for pH control is theoretically reduced when nitrification and denitrification are combined. The efficient deportation of nitrogen in wastewater treatment plants is crucial for environmental protection.

SUMMARY

In wastewater treatment plants, biological methods play a critical role in the removal of reactive nitrogen compounds, like ammonia and nitrate, from wastewater. These compounds are major contributors to water pollution and can lead to harmful algal blooms and oxygen depletion in aquatic ecosystems. The biological process primarily involves two key steps: nitrification and denitrification. During nitrification, specialized bacteria, known as nitrifying bacteria, convert ammonia into nitrite and then further into nitrate. This step is aerobic, requiring oxygen to be present. Next, denitrification takes place in an anoxic environment, where oxygen is absent or limited. Denitrifying bacteria utilize the nitrate as an electron acceptor, converting it into nitrogen gas or nitrous oxide. This process effectively eliminates reactive nitrogen compounds from the wastewater. To facilitate the biological treatment, wastewater treatment plants employ various systems, such as activated sludge processes, sequencing batch reactors, and biofilters. The efficiency of the biological method depends on factors like temperature, pH, and organic carbon's accessibility as a carbon source for denitrifying bacteria. By utilizing biological methods for reactive nitrogen compound removal, wastewater treatment plants contribute to minimizing the impact of wastewater discharges on the environment. Proper treatment ensures that the treated water meets regulatory standards and protects aquatic ecosystems, promoting environmental sustainability and safeguarding public health.

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CONFLICT OF INTEREST

The authors declare there is no conflict of interest.





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ABBREVIATIONS

WWTPs - Wastewater treatment plants
BNR - Biological Nitrogen Removal
AOB - Ammonia-Oxidizing Bacteria
DO - Dissolved Oxygen
NOB - Nitrite-Oxidizing Bacteria
AMO - Ammonia Monooxygenase
NH₂OH - Hydroxylamine
HAO - Hydroxylamine dehydrogenase
HZS - Hydrazine synthase
PHB - Poly-b-hydroxybutyrate

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Table 1: Common nitrogen amounts in sewage from cities and farms

Source	Concentration N (mg/l)
Municipal sewage	20–85
Garbage dump wastewater	1825–2985
Livestock (pigs)	390–690
Run off at the slaughterhouse	160–280

Table 2: Ammonia-oxidizing bacteria that are chemolithotrophic are widespread in many settings.

Representative species-	Isolation environment
<i>Nitrosomonas aestuarii</i>	Aerobic soils
<i>Nitrosomonas europaea</i>	Activated sludge from a wastewater treatment facility; aerobic soils
<i>Nitrosomonas cryotolerans</i>	Marine waters
<i>Nitrosomonas eutropha</i>	Municipal and industrial sewage treatment plants
<i>Nitrosomonas halophila</i>	Alkaline soda lake waters; marine waters
<i>Nitrosomonas marina</i>	Marine waters, salt lakes



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<i>Nitrosomonas mobilis</i>	Brackish water from North Sea; ammonia- rich wastewater
<i>Nitrosomonas nitrosa</i>	Activated sludge from thermal power plant; eutrophic environment
<i>Nitrosomonas</i> <i>gotropha</i>	Activated sludge from wastewater treatment plant; industrial sewage treatment plants
<i>Nitrosomonas stereois</i>	Composed cattle manure
<i>Nitrosomonas ureae</i>	Aerobic soils, freshwater
<i>Nitrospira multiformis</i>	Aerobic surface soils

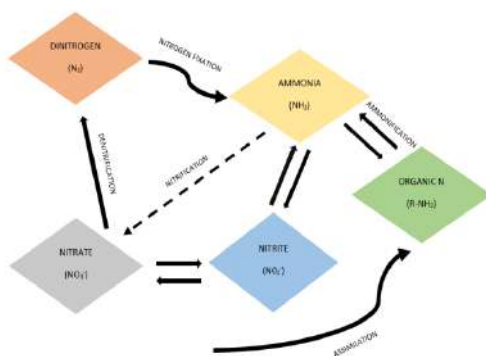


Figure 1: The biological nitrogen cycle

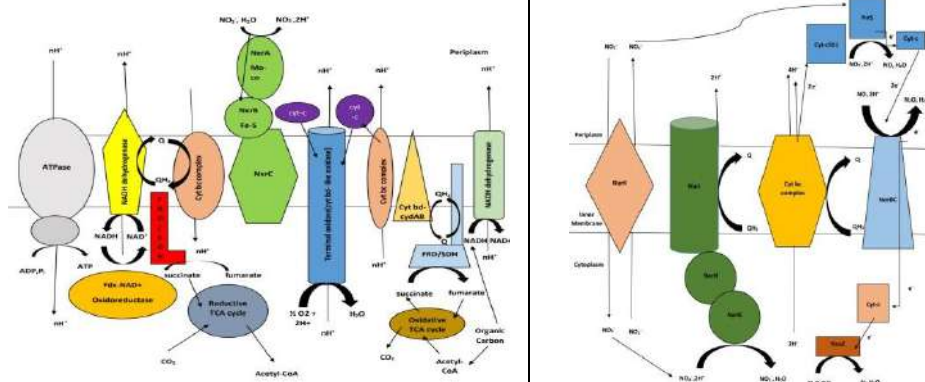


Figure 2: Suggested mechanism for the oxidation of periplasmic nitrite in *Nitrospira* species.





Revolutionizing Efficiency Productivity and Safety in Industrial Environments

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ABSTRACT

The Industrial Internet of Things (IIoT) uses networked industrial equipment and sensors to increase efficiency, output, and safety in industrial settings. The amazing automation and data-driven decision-making capabilities of IIoT applications revolutionize organizations' operations. Many industries might benefit from IIoT applications in predictive maintenance, supply chain optimization, energy management, and quality control. Predictive maintenance predicts repair requirements using real-time sensor data, decreasing disruptions and boosting efficiency. Supply chain optimization enabled by IIoT provides for product and material flow monitoring and improvement, decreasing waste and increasing efficiency. This paper explores the profound impact of IIoT applications on revolutionizing efficiency, productivity, and safety within industrial environments. By integrating a range of sensors, modules, and devices such as dust and LPG gas sensors, WiFi UART, PWM drivers, and more, IIoT enables predictive maintenance, supply chain optimization, energy management, and quality control. IIoT-enabled software monitors production lines for faults and guarantees that items meet quality standards. IIoT applications help businesses increase efficiency, makes data-driven choices, and improves safety and sustainability. More unique and ground breaking IIoT applications will develop across industrial sectors as technology



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improves, shifting operational paradigms and propelling businesses toward a more connected and smarter future.

Keywords: Dust Sensor, LCD 16*2 I2c, LPG Gas Sensor, Industrial Internet of Things

INTRODUCTION

The term "Industrial Internet of Things" (IIoT) describes the use of sensors and networked industrial equipment to boost production, efficiency, and safety [1]. Applications built for the IoT provide previously unheard-of levels of automation and data-driven decision-making, revolutionizing how businesses are run [2]. Putting IIoT apps to use in critical areas, including predictive maintenance, asset monitoring, supply chain optimization, energy management, and quality control [3]. When needed, predictive maintenance forecasts are based on real-time sensor data, decreasing disturbance and increasing overall efficiency [4]. Asset tracking allows businesses to keep track of their equipment, cars, and other assets, allowing for better utilization and planning [5]. Supply chain optimization uses IIoT to monitor and improve the flow of goods and commodities, decreasing waste and increasing efficiency [6]. Energy management systems that use IIoT monitor energy use and suggest opportunities for improvement, allowing organizations to save expenses and increase sustainability [7]. Quality control applications employ the Industrial Internet of Things (IIoT) to monitor manufacturing processes, discover flaws, and guarantee that goods satisfy high-quality requirements [8]. Overall, IIoT applications assist businesses in operating more effectively, making data-driven choices, and improving safety and sustainability [9]. We predict even more inventive IIoT applications in the industrial sector as technology advances [10-12]. The Industrial Internet of Things (IIoT) is changing how firms function in manufacturing environments. With the proliferation of networked devices and sensors, the Internet of Things (IoT) allows unprecedented levels of automation and data-driven decision-making, resulting in enhanced efficiency, productivity, and safety [13-17]. Using linked devices, equipment, and sensors in industrial settings to gather and analyze real-time data is called IIoT [18].

This information is then utilized to optimize operations, decrease downtime, improve quality control, and increase efficiency. Machines and equipment can connect, exchange data, and make autonomous choices thanks to the IIoT, resulting in quicker and more accurate decision-making [19-21]. One of the primary advantages of IIoT is predictive maintenance, which involves assessing real-time data from sensors to foretell when repair is needed [22]. This enables repair to be conducted before a problem becomes significant, saving downtime and increasing equipment lifetime. Predictive maintenance also allows organizations to more effectively plan maintenance schedules and save maintenance expenditures [23]. Another key use of IIoT is asset monitoring, which assists organizations in keeping track of their equipment, cars, and other assets. This improves asset planning and utilization, decreasing waste and enhancing efficiency [24]. Asset monitoring may also be used to optimize logistics and supply chain management and detect possible difficulties or theft. Supply chain optimization is another area where IIoT may have a huge influence [25]. IIoT may help organizations optimize their supply chains, decrease waste, and enhance efficiency by tracking the flow of products and commodities in real time [26]. This covers inventory tracking, shipping route optimization, and warehouse operations monitoring [27].

Background study

AL-Hawawreh et al. [1] developed an ADS model using deep learning to detect harmful acts in Industrial IoT (IIoT) environments through TCP/IP data. Their model improved detection rates and reduced false alarms using unsupervised and supervised learning techniques on network data. Chen, W. [7] explored smart manufacturing, suggesting a design for IIoT-based smart factories. They focused on real-time tracking and monitoring of manufacturing processes using IoT technologies like RFID and wireless sensor networks, emphasizing the need for further research in AI and machine learning for intelligent manufacturing. Magomadov, V. S. [17], to sum up, the Internet of Things has significantly impacted many facets of our lives and will likely continue to do so. The



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healthcare industry, traffic management, the entertainment industry, and many others will all benefit greatly. The effect of the Internet of Things on the industrial sector is expected to be similar. Munirathinam, S. [19] highlighted the potential of IIoT to revolutionize industries, from automated factories to wearable sensors. IIoT-enabled systems, like autonomous vehicles and adaptable lighting, can improve safety, sustainability, and health. Tabaa, M. et al. [25] Major issues have arisen in the production and usage of electrical energy in some nations. In addition, the widespread impact of global warming renders their existing electrical infrastructure inadequate. The world's total CO₂ emissions are close to 32840 Mt. The increased burning of fossil fuels is a major contributor to the steady rise in this CO₂ concentration. Attention has recently been focused on urbanization, especially with associated conflicts. More than 54% of the world's population is expected to reside in urban areas in 2014, and this number is projected to climb to 72% by the year 2050.

MATERIALS AND METHODS

The Industrial Internet of Things (IIoT) application in industrial contexts depends on a smart mix of cutting-edge materials and innovative methodologies. The capacity of IIoT to improve efficiency, productivity, and safety depends on the smooth integration of diverse components ranging from sensors to communication modules. This section gives an overview of the materials and methodologies used in our research, illustrating how these components work together to effect a paradigm change in industrial processes. The ESP32 board, LCD, GAS Sensors, and Dust Sensors all need 5V DC, but the DHT11 requires 3.3V. The ESP32 may be powered by USB, 12V Adapter, or 12V/2A Switching Mode Power Supply. Because its VCC and ground pins are coupled to the common VCC and ground, the ESP32 board's 3.3V output is utilized to power the other components. LPG and ALCOHOL sensors are attached to ESP32 analogue pins D34 and D35, which are used to read LPG and Alcohol readings in PPM, respectively, whilst the dust sensor is connected to ESP32 D25th pin as digital input. Fans fault detectors are linked as analogue inputs to D32 and D33 pins. A DHT temperature and humidity sensor is linked to ESP32's D5 digital input to read temperature and humidity. LCD is linked to the I2C protocol, which is linked to the ESP32's SCL (D22) and SDA (D21). RFID reader is attached to ESP32's SPI port. Buzzer and Siren are attached to D4 and D2 as digital outputs, respectively, while fan1 and fan2 are connected to the ESP32's D14 and D27 pins as PWM outputs to regulate fan speeds. A "thing" is any inanimate item that can execute an action (such as turning on or off a light, opening or shutting a door, modifying the rotation speed of a motor, etc.) that is outfitted with sensors that collect data for transmission over a network. This vast category includes refrigerators, lamps, houses, automobiles, industries, and rehabilitation equipment. In certain circumstances, sensors do not need to be physically linked to the goods themselves; they must only monitor what is happening around them.

Cloud gateway Providing encrypted data flow and compression enables edge gateways and cloud IoT backends to connect safely and effectively. It also assures protocol compatibility and changes its communications with field gateways so that they function with the protocols of the individual gateways.

Streaming data processor regulates data flow from sources to a data lake. No data may ever be lost or destroyed by mistake.

Security monitoring Regarding the IoT, security is a major issue. Large amounts of data generated by interconnected devices must be delivered safely and kept safe from hackers. The flip side is that Internet-connected devices might serve as entry points for cybercriminals. Additionally, cybercriminals can access the IoT system's "brain" and exert control over the entire system.

DUST SENSOR

Expanding on the particle counting concept, the DSM501A PM_{2.5} Dust Sensor Module provides an advanced method of quantifying particle concentration within a given volume, including particles produced by automated heated suction systems, as demonstrated by Kobayashi, M. et al. (2018) in 2018. This sensor module, which has digital input and output capabilities, is smoothly incorporated into the system architecture, allowing the detection of particulate matter such as dust, smoke, and pollution. Using IIoT capabilities, these dust sensors deliver real-time



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data that is critical for maintaining workers' continued well-being. By continuously monitoring air quality, these sensors help protect employees' health and safety, emphasizing their position as an essential component in searching for ideal working conditions. A dust sensor, particulate matter (PM) or air quality sensor detects and monitors the amount of airborne particles or dust in the surrounding environment (see Figure 2). It is often used to quantify particle pollution in indoor and outdoor air quality monitoring systems.

LPG GAS SENSOR

The LPG Gas Sensor, similar to the particle counter idea in our integrated sensor architecture, plays a crucial role in actively detecting the presence of LPG (liquefied petroleum gas) in the environment. This sensor, which has digital input and output capabilities, smoothly integrates with the system developed by Latyshev, V. M. et al. (2017) to monitor gas levels and emissions. It provides real-time data on gas concentrations through IIoT-enabled capabilities, enhancing industrial safety measures. Continuously attentive, the sensor sends out fast notifications when it detects excessive gas levels, allowing for quick actions that protect personnel and avert any accidents. The sensor's combination of technology and safety demonstrates our dedication to improving industrial settings via real-time information for actionable results. Gas detectors are seen in Figure 3. A gas sensor is a device that detects and quantifies the presence of a certain gas in its immediate surroundings. They are used in various industries for air quality monitoring, security checks, and process control, as well as in residences and research facilities.

I2C MODULE FOR 16X2 (1602) CHARACTER LCD**Description**

By default, these modules use the I2C addresses 0x27 or 0x3F. The module's version may be determined by inspecting the black I2C adaptor board at its base. The default address for pads designated A0, A1, and A2 is 0x3F. If the address contains no pads, it will be set to 0x27. The display's contrast may be modified using a knob on the module's bottom. As a result, the text display settings on the screen may need to be adjusted. A sensor module, or a module sensor, is a tiny and integrated device that combines a sensor or many sensors with additional components such as signal conditioning circuits, amplifiers, and digital interfaces (see Figure 4).

LIQUID CRYSTAL DISPLAY (LCD)

As the name implies, liquid crystal displays (LCDs) use materials that mix liquid and crystal qualities. Instead of dissolving, they have a temperature range where their molecules are almost as mobile as in a liquid while staying ordered like those in a crystal Jones, J. C. (2018). LCDs provide a clear and straightforward medium for presenting real-time data from various sensors, equipment, and processes in an industrial setting. Operators can instantly monitor critical elements such as temperature, pressure, and production rates, enabling them to make informed decisions based on real-time data. Figure 5 depicts an LCD Pin Diagram. The pin diagram of an LCD (Liquid Crystal panel) module or panel illustrates the physical arrangement and connecting points. It depicts the pin layout of the LCD and serves as a guide for connecting the LCD to a microcontroller or other electrical equipment.

WIFI UART

Integrating WiFi UART, a fusion of WiFi technology and UART communication, constitutes a pivotal element in our endeavour to transform industrial efficiency, productivity, and safety through the Industrial Internet of Things (IIoT). Comprising a WiFi module and microcontroller, this implementation establishes real-time wireless connectivity, facilitating seamless transmission of sensor data from devices like dust and LPG gas sensors. Configured to transmit data packets securely and efficiently, WiFi UART empowers remote monitoring, data-driven decision-making, and swift responsiveness, ultimately shaping a more connected and intelligent industrial landscape that leverages the advantages of wireless communication for enhanced operational insights and informed actions. Figure 6 shows WIFI UART. WIFI UART (Universal Asynchronous Receiver-Transmitter) is a communication module combining Wi-Fi (Wireless Fidelity) capabilities with UART serial communication. It allows devices with UART interfaces, such as microcontrollers or embedded systems, to establish wireless connectivity and exchange data over Wi-Fi networks.



**Nithya and Kousalya****PWM driver**

The Pulse Width Modulation (PWM) driver, strategically embedded within our holistic system design, matches the particle counter idea, emerging as a key component in our quest to alter industrial processes. The PWM driver, similar to Tree satayapun, C. (2015), integrates smoothly with our system through digital input and output, using its dynamic control capabilities to maximize the performance of electrical devices. This IIoT-enabled driver enables precise device modifications by altering the duty cycle of electrical impulses, resulting in improved energy management, simpler operations, and increased productivity. Aside from its direct control capabilities, the PWM driver exemplifies the confluence of technology and innovation, balancing accuracy and flexibility for a more efficient and integrated industrial environment. Figure 7 shows a PWM driver. A PWM (Pulse Width Modulation) driver refers to a device or circuit that generates PWM signals and controls the intensity or speed of electrical devices.

Temperature & Humidity Sensor

IIoT-integrated sensors provide continuous monitoring, enabling operators to make real-time modifications to increase production efficiency and product quality Bi S. et al. (2021). Many industrial goods are sensitive to temperature and humidity. Temperature and humidity sensors help in energy management by allowing for more accurate control of HVAC systems. Real-time data enables modifications in response to environmental circumstances, decreasing energy waste and expenditures. As seen in Fig. 8, Measures Both Temperature and Humidity A hygrometer, or temperature and humidity sensor, is a tool for keeping tabs on environmental conditions by measuring and recording air temperature and humidity data. It provides valuable data for various applications, including weather monitoring, HVAC systems, agriculture, indoor climate control, and industrial processes.

BUZZER AND SIREN

The Buzzer and Siren components are at the centre of our entire industrial progress plan, mirroring the spirit of the particle counter idea and playing crucial roles in our objective for revolutionary change. These aural alarm mechanisms, which use digital input and output interfaces, naturally integrate into our system design, reflecting the need for real-time alerts suggested by Azad P. et al. (2019) to assure operational safety and effectiveness. Within the IIoT framework, the Buzzer and Siren serve as attentive guardians, alerted by particular occurrences such as gas leaks or unusual particle levels and quickly communicating critical information to staff for quick reactions. These alert mechanisms, which use IIoT capabilities, improve real-time monitoring and remote alerts, demonstrating our commitment to proactive event mitigation and building a safer industrial domain. In this way, the Buzzer and Siren components encapsulate the convergence of technology and safety, aligning with our overarching goal of cultivating a more intelligent, interconnected industrial landscape that prioritizes safety and operational excellence through real-time awareness and prompt interventions. Figure 9 shows buzzers, Buzzers, and sirens are acoustic signalling devices that produce loud and attention-grabbing sounds in various applications. They are designed to generate audible alerts, warnings, or notifications to attract attention and convey important information in different settings.

POWER SUPPLY

Every electronic gadget or piece of equipment needs a steady power supply. Almost every electronic device we own, from TVs to printers to music players, has an inbuilt power supply that converts the incoming alternating current mains voltage to a more controllable direct current voltage. The most common power supply circuit design is the SMPS (Switching Mode Power Supply). It converts power from a wall socket to a regulated 12V DC. The system takes a 12V input for the Arduino Uno power supply and, with the aid of Voltage regulators IC7805 and filters, converts it to two 5V outputs. The LCD 16x2, DUST SENSOR, and WIFI MODULE all need power from the 5V sources. Figure 10 shows that a power supply, also known as a power source or PSU (Power Supply Unit), is essential in electronic systems that provide electrical energy to power other devices or components. It converts available input power from a given source into a usable form that matches the requirements of the load it is supplying.



**Nithya and Kousalya****Fixed voltage regulators**

A common kind of integrated circuit is a voltage regulator. Every regulator part—reference source, comparator amplifier, control device, and overload protector—is integrated into a single circuit. Integrated circuits may control a constant positive voltage, a negative voltage, or a variable voltage. Power ratings for the regulators range from mill watts to tens of watts, and they may be set to work with load currents of hundreds of mill amperes to tens of amperes. An uncontrolled DC input voltage V_I is linked to one terminal of a fixed three-terminal voltage regulator, the regulated DC output voltage V_O is attached to the second terminal, and the third terminal is connected to the ground. Figure 11 illustrates a Constant-current regulator. No matter the input voltage or load circumstances, a fixed voltage regulator will always provide the same steady and consistent output voltage. It is commonly used to regulate and control the voltage supplied to electronic circuits or components, ensuring they receive a consistent and reliable power source.

RESULTS AND DISCUSSION

Industrial IoT (Internet of Things) applications use IoT technologies and devices in various industrial settings to enhance operational efficiency, optimize processes, and improve overall productivity. These applications leverage the power of connected devices, sensors, data analytics, and automation to enable real-time monitoring, data analysis, and intelligent decision-making in industrial environments. Figure 12 shows an industrial setup. An industrial setup is a complex environment for various industrial operations, such as manufacturing, production, and processing. It typically combines machinery, equipment, infrastructure, and processes to achieve specific production goals. Figure 13 shows the data acquisition and control unit. A data acquisition and control unit (DACU) is a device or system used to gather and monitor data from various sources and control connected devices or processes in industrial or scientific applications. It serves as a central hub for acquiring, processing, and transmitting data and issuing commands for controlling external devices or systems. Figure 14 shows sensors in industrial. Sensors play a crucial role in industrial settings by enabling the measurement and monitoring of various physical parameters and environmental conditions. They provide valuable data for process control, quality assurance, safety monitoring, and overall operational efficiency.

CONCLUSION

Finally, the Industrial Internet of Things (IIoT) is transforming the industrial environment by reinventing how firms operate, optimize, and assure safety. IIoT applications provide new prospects for better efficiency, higher production, and increased safety standards by using the power of networked equipment, sensors, and data-driven insights. The use of dust and LPG gas sensors and modern technologies like WiFi UART, PWM drivers, and others exemplifies the potential of IIoT to significantly enhance predictive maintenance, supply chain optimization, energy management, and quality control. These applications decrease downtime and disturbances, waste and inefficiencies in resources, resulting in cost-effectiveness and sustainability. Furthermore, the capacity of IIoT-enabled software to continually monitor manufacturing lines for defects and deviations guarantees that goods satisfy high-quality requirements regularly. These real-time monitoring and decision-making capabilities enable firms to make educated decisions, improve operations, and compete in an ever-changing industrial context.

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Figure 7: PWM driver



Figure 8: Temperature & Humidity Sensor



Figure 9: Buzzers and Siren

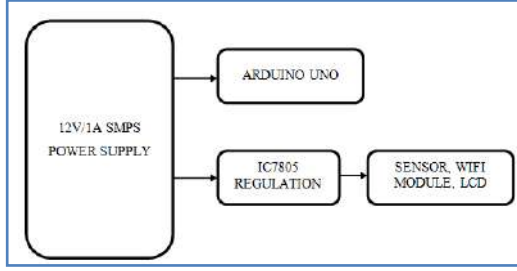


Figure 10: Power Supply

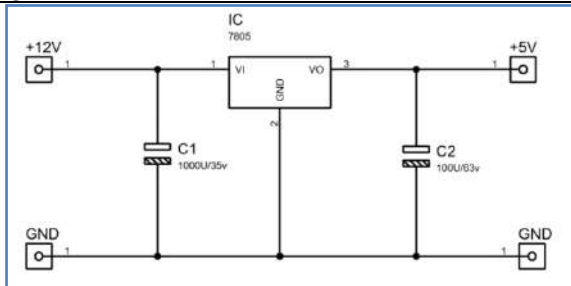


Figure 11: Fixed voltage regulators



Figure 12: Industrial setup



Figure 13: Data acquisition and control unit



Figure 14: Sensors in industrial





Properties of Binary γ -Regular Open Sets in Binary Topological Space

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ABSTRACT

In this paper, we investigate some properties of binary γ -regular open sets in binary topological space. And also we discuss the relation between binary γ -regular open sets and other open sets, binary γ -semi open sets, binary γ -preopen sets, binary γ - α -open sets, binary γ - β -open sets, binary γ - b -open sets.

Keywords: binary γ -regular open set, binary γ -regular closed set

INTRODUCTION

The concept of binary topology from X to Y is introduced by S. Nithyanantha Jothi and P. Thangavelu [13]. In the year 1979, S. Kasahara [5] imposed the operation γ of a topology τ concept. H. Ogata [17] proposed a new concept of γ -open set and he also analysed the related topological assets of the associated topology τ_γ . G.S.S. Krishnan and K. Balachandran [7] investigated the concept γ -preopen sets. G.S.S. Krishnan and K. Balachandran [8] investigated the concept γ -semiopen sets. N.Kalaivani & G.S.S. Krishnan [2] introduced α - γ -open sets in topological spaces. K. Muthulakshmi, M. Gilbert Rani [10] introduced Binary γ -open sets in Binary Topological Space. K. Muthulakshmi, M. Gilbert Rani [11] introduced the definition of Binary γ -regular open set.

Preliminaries

Definition 2.1:[10]

Let (A, B) be a subset of (X, Y) . Then (A, B) is binary γ -open in (X, Y, \mathcal{M}) if and only if $(A, B) = b\gamma\text{-int}(A, B)$.





The set of all binary γ -open sets is denoted by $b\gamma$

Definition 2.2:[10]

Let (X, Y, \mathcal{M}) be a binary topological space. An operation γ on \mathcal{M} is a mapping $\gamma: \mathcal{M} \rightarrow P(X) \times P(Y)$ such that $(U, V) \subseteq \gamma((U, V))$ for every $(U, V) \in \mathcal{M}$ where $\gamma((U, V))$ denotes the value of γ at (U, V) and $P(X)$ and $P(Y)$ are power sets of X and Y respectively.

Definition 2.3:[10]

Let a nonempty set $(A, B) \subseteq (X, Y)$. A point $(x, y) \in (A, B)$ is said to be binary γ -interior of (A, B) iff there exists a binary neighborhood (M, N) of (x, y) such that $\gamma((M, N)) \subseteq (A, B)$.

The set of all such binary points is denoted by $b\gamma\text{-int}(A, B)$.

(ie) $b\gamma\text{-int}(A, B) = \{(x, y) \in (A, B) / (x, y) \in (M, N) \in \mathcal{M} \text{ and } \gamma((M, N)) \subseteq (A, B)\} \subseteq (A, B)$.

Definition 2.4:[11]

A subset (A, B) of a binary topological space (X, Y, \mathcal{M}) with an operation γ on \mathcal{M} is called

1. a binary γ -semi open set if $(A, B) \subseteq b\gamma\text{-cl}(b\gamma\text{-int}(A, B))$
2. a binary γ -preopen set if $(A, B) \subseteq b\gamma\text{-int}(b\gamma\text{-cl}(A, B))$.
3. a binary γ - α -open set if $(A, B) \subseteq b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}(A, B)))$.

The complement of a binary γ -semi open (resp, binary γ -pre open, binary γ - α -open) set is called binary γ -semi closed (resp, binary γ -pre closed, binary γ - α -closed).

Results on binary γ -regular open set

Definition 3.1

A subset (A, B) of a binary topological space (X, Y, \mathcal{M}) with an operation γ on \mathcal{M} is said to be binary γ -regular open set if $(A, B) = b\gamma\text{-int}(b\gamma\text{-cl}(A, B))$.

This definition is given in [11]. Using this definition, we discuss some results with an example.

Example 3.2

Let $X = \{a, b\}$, $Y = \{1, 2, 3\}$

Binary topology $\mathcal{M} = \{(\emptyset, \emptyset), (\emptyset, \{1\}), (\{a\}, \{1\}), (\{a\}, \{1, 2\}), (\{b\}, \emptyset), (\{b\}, \{1\}), (\{b\}, \{3\}), (\{b\}, \{1, 3\}), (\{X\}, \{1\}), (\{X\}, \{1, 2\}), (\{X\}, \{1, 3\}), (X, Y)\}$.

Let $\gamma: \mathcal{M} \rightarrow P(X) \times P(Y)$ be an operation defined as follows:

For every $(U, V) \in \mathcal{M}$,
 then $\gamma((U, V)) = \begin{cases} (U, V) & \text{if } (U, V) = (\{a\}, \{1\}) \\ (U, V) \cup (\{b\}, \{3\}) & \text{if } (U, V) \neq (\{a\}, \{1\}) \end{cases}$

The set of all binary γ -open sets $b\gamma = \{(\emptyset, \emptyset), (\{a\}, \{1\}), (\{b\}, \{3\}), (X, \{1, 3\}),$

$(\{a\}, \{1\}), (\{b\}, \{3\}), (\{a, b\}, \{1, 2, 3\}), (\emptyset, \emptyset)$ are binary γ -regular open sets.

The family of all binary γ -regular open sets is denoted by $b\gamma\text{-RO}(X, Y, \mathcal{M})$.

Definition 3.3

A subset (A, B) of a binary topological space (X, Y, \mathcal{M}) is said to be binary γ -regular closed set if $(A, B) = b\gamma\text{-cl}(b\gamma\text{-int}(A, B))$. The complement of a binary γ -regular open set is binary γ -regular closed set.

Remark 3.4

From the binary γ -regular open set definition, every binary γ -regular open set is binary γ -open set. But converse is not true. It can be seen from the following example.





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Example 3.5

In Example 3.2, $(\{a,b\}, \{1,3\})$ is binary γ -open set. But it is not a binary γ -regular open set.

Remark 3.6

Every binary γ -clopen set is both binary γ -Regular open and binary γ -regular closed.

But converse is not true.

Example 3.7

In Example 3.2, $(\{a\}, \{1\})$ is binary γ -regular open set and $(\{a\}, \{1,2\})$ is binary γ -regular closed. But they are not binary γ -clopen.

Proposition 3.8

Binary γ -regular open set and binary regular open set are independent. It is seen by the below example.

Example 3.9

Using Example 3.2,

- ❖ $(\{a\}, \{1\})$ is binary γ -regular open set but it is not binary regular open set.
- ❖ $(\{a\}, \{1, 2\})$ is binary regular open set but $(\{a\}, \{1, 2\})$ is not binary γ -regular open set.

Result 3.10

Suppose γ is an identity function on \mathcal{M} (ie) the class of all binary γ -open sets equal to the class of binary open sets (binary topological), then $b\gamma\text{-int}((A,B)) = b\text{-int}((A,B))$.

Result 3.11

The union of any two binary γ -regular open sets need not be a binary γ -regular open set.

Example 3.12

In example 3.2, $(\{a\}, \{1\})$ and $(\{b\}, \{3\})$ are binary γ -regular open sets. But the union of these two sets is $(\{a,b\}, \{1,3\})$ is not binary γ -regular open set.

Result 3.13

The intersection of any two binary γ -regular open sets is binary γ -regular open set.

Example 3.14

$(\{a\}, \{1\}) \cap (\{b\}, \{3\}) = (\emptyset, \emptyset)$ is binary γ -regular open set.

Definition 3.15

Let (X, Y, \mathcal{M}) be a binary topological space with an operation γ on \mathcal{M} . A nonempty subset (A, B) of $X \times Y$ is called binary γ - β -open set if $(A, B) \subset b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A, B))))$.

Example 3.16

In an Example 3.2,

$(\{a\}, \{1\}), (\{a\}, \{2\}), (\{a\}, \{3\}), (\{a\}, \{2,3\}), (\{a\}, \{1,3\}), (\{a,b\}, \{1,2,3\}), (\{b\}, \{1\}), (\{b\}, \{1,2\}), (\{b\}, \{1,3\}), (\{b\}, \{1,2,3\}), (\{a,b\}, \{1\}), (\{a,b\}, \{2\}), (\{a,b\}, \{3\}), (\{a,b\}, \{1,2\}), (\{a,b\}, \{1,3\}), (\{a,b\}, \{2,3\})$ are binary γ - β -open sets.

Theorem 3.17

For any nonempty subset (A, B) of a binary topological space (X, Y, \mathcal{M}) , then (A, B) is binary γ - β -open set iff $b\gamma\text{-cl}((A, B)) = b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A, B))))$.

Proof

Let a nonempty subset (A, B) be binary γ - β -open set.





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Then by definition of binary γ - β -open set,

$$(A,B) \subset b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A,B))))$$

$$b\gamma\text{-cl}((A,B)) \subset b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A,B)))) \subset b\gamma\text{-cl}((A,B))$$

$$b\gamma\text{-cl}((A,B)) = b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A,B))))$$

Conversely, assume that $b\gamma\text{-cl}((A,B)) = b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A,B))))$

$$b\gamma\text{-cl}((A,B)) \subset b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A,B))))$$

$$(A,B) \subseteq b\gamma\text{-cl}((A,B)) \subset b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A,B))))$$

$$(A,B) \subset b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A,B))))$$

Theorem 3.18

Let (X,Y,\mathcal{M}) be a binary topological space. Then for any nonempty subset (A,B) is binary γ -semi open set iff $b\gamma\text{-cl}((A,B)) = b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))$

Proof

By using the similar argument of proof of theorem 3.17, we get the following result.

Theorem 3.19

If (A,B) is binary γ -semi open set in binary topological space, then $b\gamma\text{-cl}(A,B)$ is binary γ -regular closed set.

Proof

The Proof follows 3.18.

Corollary 3.20

Let (X,Y,\mathcal{M}) be a binary topological space. Then for any nonempty subset (A,B) is binary γ -semi closed set iff $b\gamma\text{-int}(A,B) = b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))$.

Corollary 3.21

If (A,B) is binary γ -semi closed set in binary topological space (X,Y,\mathcal{M}) , then $b\gamma\text{-int}((A,B))$ is binary γ -regular open set.

Theorem 3.22

Let (A,B) be any subset of a binary topological space (X,Y,\mathcal{M}) and γ be an operation on \mathcal{M} . Then the following results

1. (A,B) is binary γ - β open set iff $b\gamma\text{-cl}((A,B))$ is binary γ -regular closed set.
2. (A,B) is binary γ - β open set iff $b\gamma\text{-cl}((A,B))$ is binary γ -semi open set.
3. (A,B) is binary γ - β open set iff $b\gamma\text{-cl}((A,B))$ is binary γ - β open set.

Proof

1. By the theorem 3.17, we get the proof.

2. Let (A,B) be binary γ - β open set.

Then by (1), $b\gamma\text{-cl}((A,B))$ is in binary γ regular closed set which is a subset of binary γ -semi open set.

$b\gamma\text{-cl}((A,B))$ is binary γ -semi open set. Conversely, let $b\gamma\text{-cl}((A,B))$ is binary γ -semi open set, Then by theorem 3.19,

$$b\gamma\text{-cl}(b\gamma\text{-cl}((A,B))) = b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-cl}((A,B)))))$$

$$b\gamma\text{-cl}((A,B)) = b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A,B)))) \text{ Then using theorem 3.17, } (A,B) \text{ is binary } \gamma\text{-}\beta\text{-open set.}$$

3. By using the similar argument of proof of (2), we get the result.

Corollary 3.23

Let (X,Y,\mathcal{M}) be a binary topological space for any subset (A,B) , then the following results

1. (A,B) is binary γ - β -closed set iff $b\gamma\text{-int}((A,B)) = b\gamma\text{-int}((A,B)) = b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A,B))))$
2. (A,B) is binary γ - β closed set iff $b\gamma\text{-int}((A,B))$ is Binary γ regular open set
3. (A,B) is binary γ - β closed set iff $b\gamma\text{-int}((A,B))$ is binary γ -semi closed set
4. (A,B) is binary γ - β closed set iff $b\gamma\text{-int}((A,B))$ is binary γ - β closed set.





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Corollary 3.24

For any subset (A,B) of a binary topological space (X,Y,\mathcal{M}) is binary γ -regular open set, then $b\gamma\text{-cl}((A,B))$ is binary γ -regular closed set and $b\gamma\text{-int}((A,B))$ is binary $b\gamma$ -regular open set.

Proposition 3.25

Let (X,Y,\mathcal{M}) be binary topological space with an operation γ on \mathcal{M} . For any subset (A,B) of (X,Y,\mathcal{M}) , then $b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A,B))))=b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))$.

Proof

We know that $b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))) \subset b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))$

$b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))) \subset b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))$

Clearly $b\gamma\text{-int}((A,B)) \subset b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))$

$b\gamma\text{-int}((A,B)) \subset b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A,B))))$

Therefore $b\gamma\text{-cl}(b\gamma\text{-int}((A,B))) \subset b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A,B))))$

Therefore $b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A,B))))=b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))$

Corollary 3.26

$b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A,B)))) = b\gamma\text{-int}(b\gamma\text{-cl}((A,B)))$, for any subset (A,B) of a binary topological space.

Result 3.27

Every binary γ -pre open set is binary γ - β open set. But converse is need not be true.

Example 3.28

In an Example 3.2, $(\{a\}, \{1\}), (\{a\}, \{2\})$ are binary γ - β open set. But they are not binary γ -preopen set.

Theorem 3.29

Let (X,Y,\mathcal{M}) be a binary topological space with an operation γ on \mathcal{M} . Let $(A,B), (C,D)$ be subsets of $X \times Y$. Then (A,B) is binary γ -preopen if and only if there exists a binary γ -regular open set (C,D) containing binary γ -preopen set (A,B) such that $b\gamma\text{-cl}((A,B))=b\gamma\text{-cl}((C,D))$.

Proof

Suppose (A,B) is a binary γ -preopen set. Then by the definition γ -pre open set,

$(A,B) \subset b\gamma\text{-int}(b\gamma\text{-cl}((A,B)))$

Suppose binary γ -preopen set (A,B) is contained in binary γ -regular open set (C,D) .

we apply $(C,D)=b\gamma\text{-int}(b\gamma\text{-cl}((A,B)))$ and binary γ -preopen set is binary γ - β open set,

(A,B) is binary γ - β open set. By using Theorem 3.17,

$b\gamma\text{-cl}((A,B))=b\gamma\text{-int}(b\gamma\text{-cl}((A,B)))=b\gamma\text{-cl}((C,D))$

Conversely, assume that binary γ -regular open set (C,D) containing (A,B) such that

$b\gamma\text{-cl}((A,B))=b\gamma\text{-cl}((C,D))$

$\Rightarrow (A,B)=b\gamma\text{-int}(b\gamma\text{-cl}((C,D)))$

Hence $(A,B) \subset b\gamma\text{-int}(b\gamma\text{-cl}((C,D)))$

$\Rightarrow (A,B) \subset b\gamma\text{-int}(b\gamma\text{-cl}((A,B)))$, because $(A,B) \subset (C,D)$.

$\Rightarrow (A,B)$ is binary γ -preopen set.

Theorem 3.30

If (A,B) is binary γ -semi open set and binary γ -semi closed subset of a binary topological space (X,Y,\mathcal{M}) with an operation γ on \mathcal{M} and also $b\gamma\text{-cl}(b\gamma\text{-int}(A,B)) \subset b\gamma\text{-int}(b\gamma\text{-cl}((A,B)))$, then (A,B) is binary γ -regular open set and binary γ -regular closed set.

Proof

By the definition of binary γ -semi-open set,

$(A,B) \subset b\gamma\text{-cl}(b\gamma\text{-int}((A,B)))$





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$$\subset b\gamma\text{-int}(b\gamma\text{-cl}((A, B)))$$

Therefore (A, B) is binary γ -regular open.

Similarly, we proved binary γ -regular closed set using the definition of binary γ -semi closed.

Definition 3.31

Let (X, Y, \mathcal{M}) be a binary topological space with an operation γ on \mathcal{M} . A nonempty subset (A, B) of $X \times Y$ is called binary γ -b-open set if $(A, B) \subset b\gamma\text{-cl}(b\gamma\text{-int}((A, B))) \cup b\gamma\text{-int}(b\gamma\text{-cl}((A, B)))$.

Lemma 3.32

Let (X, Y, \mathcal{M}) be a binary topological space with an operation γ on \mathcal{M} . Then the following results hold:

A subset (A, B) of $X \times Y$ is said to be

1. Every binary γ -preopen set is binary γ -b-open set.
2. Every binary γ -b-open set is binary γ - β -open set.

Proof:

1. Given (A, B) is a binary γ -preopen set.

Then $(A, B) \subset b\gamma\text{-int}(b\gamma\text{-cl}((A, B))) \subset b\gamma\text{-int}(b\gamma\text{-cl}((A, B))) \cup b\gamma\text{-cl}(b\gamma\text{-int}((A, B)))$. Therefore (A, B) is binary γ -b-open set.

2. Given (A, B) is binary γ -b-open set.

$$\begin{aligned} \text{Then } (A, B) &\subset b\gamma\text{-int}(b\gamma\text{-cl}((A, B))) \cup b\gamma\text{-cl}(b\gamma\text{-int}((A, B))) \\ &\subset b\gamma\text{-cl}(b\gamma\text{-int}((A, B))) \cup b\gamma\text{-cl}(b\gamma\text{-int}((A, B))) \end{aligned}$$

$$\subset b\gamma\text{-cl}(b\gamma\text{-int}(b\gamma\text{-cl}((A, B))))$$

Therefore (A, B) is binary γ - β -open set.

Result 3.33

The converse of the above lemma need not be true as seen by the example below:

In an example 3.2, $(\{a\}, \{1\}), (\{b\}, \{3\})$ are binary γ -b-open but they are not binary γ -pre open.

$(\{a\}, \{2\})$ is a binary γ - β open set but it is not a binary γ -b-open set.

Theorem 3.34

If (A, B) is a binary γ -preopen set and binary γ -semi closed set of space (X, Y, \mathcal{M}) with an operation γ on \mathcal{M} , then the subset (A, B) is binary γ -open set.

Proof

Given (A, B) is binary γ -preopen set, so $(A, B) \subset b\gamma\text{-int}(b\gamma\text{-cl}((A, B)))$

Since (A, B) is binary γ -semi closed,

$$(A, B) \supset b\gamma\text{-int}(b\gamma\text{-cl}((A, B)))$$

Hence $(A, B) = b\gamma\text{-int}(b\gamma\text{-cl}((A, B)))$

(A, B) is binary γ -regular open set. Clearly (A, B) is binary γ -open set.

Lemma 3.35

Let (A, B) be a subset of binary topological space (X, Y, \mathcal{M}) with an operation γ on \mathcal{M} . If (A, B) is binary γ - α open set and binary γ - β -closed, then (A, B) is binary γ -open set.

Proof

Given (A, B) is binary γ - α -open set.

$$\text{Then } (A, B) \subset b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A, B))))$$

Since (A, B) is binary γ - β -closed, $(A, B) \supset b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A, B))))$

$$\text{Hence } (A, B) = b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A, B))))$$

$$\Rightarrow b\gamma\text{-int}((A, B)) = b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A, B)))) = (A, B)$$

$$b\gamma\text{-int}(b\gamma\text{-cl}((A, B))) = b\gamma\text{-int}(b\gamma\text{-cl}(b\gamma\text{-int}((A, B)))) = (A, B)$$

$$(A, B) = b\gamma\text{-int}(b\gamma\text{-cl}((A, B)))$$

(A, B) is binary γ -regular open set.





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We know that binary γ -regular open set is binary γ -open.(This result proved in [11]) Therefore (A,B) is binary γ -open set.

CONCLUSION

In this paper, deals the properties of binary γ -regular open sets as well as the inter relation between other binary γ -open sets. From the relation we have a fruitful result . In any future work, I establish the relations and results to some other domain.

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Antimicrobial Activity of Cowdung and Buffalo Dung Extracts against Selected Human Pathogens

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ABSTRACT

In a country like India, cow holds one of the notable position among the livestock. Panchgavya has been the subject of increasing research attention due to its potential as a therapeutic agent for various human illnesses and its various health benefits. Among them, cow dung serves as a home for a variety of microbial organisms which can produce metabolites that may serve positively to the human race. The main objective of the study was to investigate the antimicrobial potential of cow and buffalo dung extracts against four human pathogens: *Klebsiella pneumoniae*, *Escherichia coli*, *Streptococcus pneumoniae*, and *Staphylococcus aureus*. Buffalo dung and cow dung extracts were prepared in solvents such as acetone, ethanol, and chloroform. From the study it was found that the chloroform extract of cow dung efficiently inhibited the growth of *Streptococcus pneumoniae* with an inhibition zone of 13mm. Similarly, the acetone extract of cow dung showed effectiveness against *Streptococcus pneumoniae* and *Staphylococcus aureus* with 10mm inhibition zone each. Buffalo dung extract also hindered the growth of *Streptococcus pneumoniae* with 14mm inhibition zone. The results imply that bio dung could serve as an alternative treatment source for infections caused by these bacteria, especially for *Streptococcus pneumoniae* and *Staphylococcus aureus* strains. However, *Escherichia coli* and *Klebsiella pneumoniae* showed more resistance to dung extracts.

Keywords: Cow dung, Buffalo dung, Antimicrobial Activity, *E.coli*, *Klebsiella pneumoniae*, *Streptococcus pneumoniae*, *Staphylococcus aureus*.





INTRODUCTION

In a nation like India, where people embrace their culture and customs with great fervour, ancient Vedic lifestyles constantly impact modern lifestyles, and traditional medical practises are highly valued, scientists and researchers are constantly striving to develop novel, cutting-edge methods that could be environmentally sustainable. Cow dung, which can range in hue from green to black, is the undigested plant matter that has made its way through the animal's digestive system. Together with organic materials like fibrous material, it is composed of liquid digest leftover from fermentation, absorption, filtering, acidification, and then absorption again [1]. Because of its numerous uses in agriculture, as an energy source, to protect the environment, and for medical purposes, cow dung has been called a "gold mine"[2]. People who have grown tired with the harsh allopathic treatment are now adopting cowpathy medications and benefiting from Panchgavya products for a variety of illnesses [3]. Numerous studies have assessed the antibacterial and antifungal qualities of cow dung extract against a variety of pathogenic strains of microorganisms in a variety of media, including n-hexane, ethanol, methanol, distil water, and chloroform.

It has proven to be quite successful in combating certain types of microorganisms [4]. From cow dung, *Paenibacillus favisporus* sp., a member of the xylanolytic bacteria, was shown to generate a wide range of hydrolytic enzymes, including urease, β -galactosidase, gelatinase, amylases, and xylanases[5]. The microbial enzymes found in cow dung have a wide range of uses. Enzymes including lipase, protease, and esterase lipase are produced by a number of isolates from cow dung [6]. In accordance to several studies that shown broad-spectrum antibacterial activity, cow dung microflora may be studied for potential medicinal benefits and the creation of novel antimicrobial compounds [7]. Dung extracts of cow and Buffalo have antibacterial activity and efficacy against various microorganisms, suggesting a potential, cost-effective future treatment for antibiotic-resistant illnesses. This sustainable source can always prove to be effective as an alternative way of antibiotic construction if studied properly. This research involves a novel combination of solvent and test samples to assess their impact on the chosen bacterial strains.

MATERIALS AND METHODS

Sample collection

Cow dung (Indian cow) and buffalo dung samples were collected from Mammood, Pathanamthitta, Kerala. The selected bacterial samples include, two gram-negative pathogenic strains namely *Klebsiella pneumoniae* and *Escherichia coli* along with two-gram positive pathogenic strains -*Streptococcus pneumoniae* and *Staphylococcus aureus*.

Preparation of cow dung and buffalo dung powder

500 g each of fresh cow dung and buffalo dung were collected and shadow dried for 5 days. The dried cow dung was powdered using a sterilised mortar and pestle. The powdered material had a net weight of approximately 139 g and 103g respectively.

Preparation of cow dung and buffalo dung extract

5g each of powdered cow dung was added into conical flask containing 50 ml of Acetone, Chloroform and Ethanol. All the conical flasks containing the samples are tightly plugged in with sterilized non adsorbent cotton. The flasks were kept in a rotary shaker for 3 days for continuous / discontinuous stirring. After 3 days, the extract was filtered using a Whatman No.1 filter paper and stored in vials for future use. Same procedure was done for buffalo extract also.

Preparation of disc containing test sample

Empty disc having a diameter of 5 mm was impregnated with 50 μ l (2 mg/disc) of acetone, chloroform and ethanol extract of cow dung as well as acetone, chloroform and ethanol extracts of buffalo dung and dried in the hot air oven. The procedure was repeated till the disc gets saturated. These discs are used for studying the antimicrobial activity of the cow dung extract and buffalo dung extracts on four test human pathogens.



**Shyama and Shaloo ann Thomas****Control**

For preparing the control disc, 5mm empty disc is impregnated with 50 μ l (2 mg/disc) acetone, chloroform and ethanol respectively without the addition of the dung extracts.

Antibiotic sensitivity test

Kirby-Bauer method or disc diffusion antibiotic sensitivity testing, was conducted to determine the sensitivity of the bacterial strain towards antibiotics. The selected bacterial strains were inoculated on Mueller-Hinton agar plates using a sterile cotton swab. The dung extract impregnated discs were carefully placed onto the microbe carpeted plate, spacing them out 24 mm apart and 15 mm from the edge. The agar plates were then incubated at 37°C for 18 to 24 hours. The zone of bacterial growth inhibition for each disc was measured and noted for its diameter[8].

RESULTS AND DISCUSSION

In this current investigation, the objective was to empirically demonstrate the capability of dung samples to either eliminate or restrain the growth of the selected harmful microorganisms. Control was set up, which indicated that the solvents without the test samples (cow dung and buffalo dung) had only small zone of inhibition when compared to the actual extracts of dung samples which ruled out the antimicrobial potential of dung samples. Table 1 shows the zone of inhibition of the solvents used.

The antimicrobial activities of different solvent extract of the cow dung against *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae* and *Escherichia coli* in terms of inhibition zone exhibited by the bacteria are shown in Table 2. Results obtained revealed that the cow dung extract possess potential antibacterial activity against some of the tested bacteria. Acetone extract of cow dung showed 7 mm, 10mm, 10mm and 7mm of zone of inhibition against test organism: *E. coli*, *Staphylococcus aureus*, *Streptococcus pneumoniae* and *Klebsiella* respectively. Similarly, the cow dung extract of ethanol has an activity of 7mm, 7mm and 13mm of zone of inhibition against *E. coli*, *Staphylococcus aureus* and *Streptococcus pneumoniae* respectively. But *Klebsiella* proved to be highly resistant to ethanol extract of cow dung. Furthermore, the chloroform extract of cow dung exhibited antimicrobial activity that is measured using zone of inhibition i.e., 9mm, 8mm and 9mm against *E. coli*, *Staphylococcus aureus* and *Streptococcus pneumoniae* respectively (Fig. 1).

The antimicrobial activities of different solvent extract of the buffalo dung against *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae* and *Escherichia coli* in terms of inhibition zone exhibited by the bacteria are shown in Table 3. The buffalo dung extract showed partial antimicrobial activity against the test organism. *Streptococcus pneumoniae* showed sensitivity to acetone extract of buffalo dung, but the same microorganism was resistant to ethanol and chloroform extract. The ethanol extract of buffalo dung exhibited a zone of inhibition of 6mm, 8mm and 14 mm against *E. coli*, *Staphylococcus aureus* and *Streptococcus pneumoniae* respectively. Correspondingly the ethanol extract and chloroform extract of buffalo dung had a slight antibiotic activity only on *Staphylococcus aureus* (6mm & 8mm) respectively (Fig. 2).

The current observation leads to the result that, the cow dung possesses great antimicrobial property and can be employed in constructing antibiotics against *Staphylococcus aureus* and *Streptococcus pneumoniae* which goes in line with the study conducted by S Rajeswari et al., in the year 2018. It can be also concluded that buffalo dung has only partial antibiotic activity against the test pathogenic strains used and must be studied further more in detail to extract the complete strength of the antibiotic property. The findings of the present study have close relation with the study conducted by Arabinda Nayak and Shivani Gohel, 2019 in which the results of the investigation showed that desi cow dung-chloroform extracts have greater antimicrobial properties against human infections [9]. It is critical to begin comprehensive screening of cow dung due to the significant potential of this underutilised resource to generate novel bioactive chemicals for the discovery of new medications. Antimicrobial agents may be studied for possible use in the treatment of human illnesses. Given its abundance and low cost, cow and buffalo dung may be





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used in the future as a cure for a variety of illnesses. Due to their medicinal qualities, this cow and buffalo dung may be utilised to make treatments for a range of disorders caused by pathogenic microorganisms that are resistant to antibiotics.

CONCLUSION

According to the results of the current investigation, Indian cow dung was more effective at fighting microbes than buffalo dung extracts. Acetone extract of cow dung shown antibacterial efficacy against all the selected organisms with different zones of inhibition. *Staphylococcus aureus* was susceptible to acetone extract of cow dung (10mm) but only a very small zone of inhibition for chloroform (8mm) and ethanol extract (7mm) was exhibited (Fig. 3). *Klebsiella pneumoniae* was resistant to both ethanol and chloroform extract and showed a slight sensitivity to acetone extract. *Streptococcus pneumoniae* and *Escherichia coli* showed sensitivity to all the extracts of cow dung in different ranges. The buffalo dung extract showed partial antimicrobial activity against the test organism. *Streptococcus pneumoniae* was susceptible to acetone extract of buffalo dung (14mm), but the same microorganism was resistant to ethanol and chloroform extract (Fig. 4).

The cow dung extract of chloroform was having a zone of inhibition of 13mm against *Streptococcus pneumoniae* and cow dung extract of acetone was also effective against *Staphylococcus aureus* and *Streptococcus pneumoniae*. In conclusion, the result of the present study supports the scientific results as well as Vedas in ancient times and suggest that dung extracts possess compounds with antimicrobial properties that can be further studied and explored for antimicrobial activity. Future research on this topic paves a way to demonstrate that folk medicine can be as effective as modern and chemical medicines to combat the pathogenic strains. As microorganisms evolve a resistance to antibiotics and other synthetic medications, new natural therapeutic alternatives can be researched and employed to treat a variety of ailments that these microbes cause.

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CONFLICT OF INTEREST

No conflict of interest reported.

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Table 1: Zone of inhibition (mm) produced by the solvents without the test sample.
CONTROL

CHEMICAL	TEST ORGANISM			
	<i>Staphylococcus aureus</i>	<i>Escherichia coli</i>	<i>Streptococcus pneumoniae</i>	<i>Klebsiella pneumoniae</i>
Acetone	6mm	5mm	6mm	4mm
Chloroform	5mm	5.4mm	4mm	5mm
Ethanol	5mm	7mm	4mm	5mm

Table 2: Zone of inhibition (in mm) produced by cow dung extracts against the test organisms.

EXTRACT OF COW DUNG	TEST ORGANISM			
	<i>Staphylococcus aureus</i>	<i>Escherichia coli</i>	<i>Streptococcus pneumoniae</i>	<i>Klebsiella pneumoniae</i>
ACETONE	10 mm	7 mm	10 mm	7mm
CHLOROFORM	8 mm	9 mm	13 mm	4mm
ETHANOL	7 mm	7 mm	8 mm	4mm

Table 3: Zone of inhibition (in mm) produced by buffalo dung extracts against the test organisms.

EXTRACT OF BUFFALO DUNG	TEST ORGANISMS			
	<i>Staphylococcus aureus</i>	<i>Escherichia coli</i>	<i>Streptococcus pneumoniae</i>	<i>Klebsiella pneumoniae</i>
ACETONE	8 mm	6 mm	14 mm	5mm
CHLOROFORM	8 mm	4.3mm	5mm	4.6mm
ETHANOL	6 mm	5.4mm	4.9mm	4mm

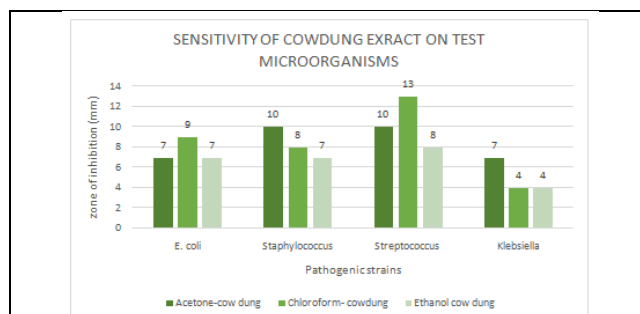


Figure 1: Graph showing the activity of cow dung extracts (zone of inhibition in mm) on test organisms.

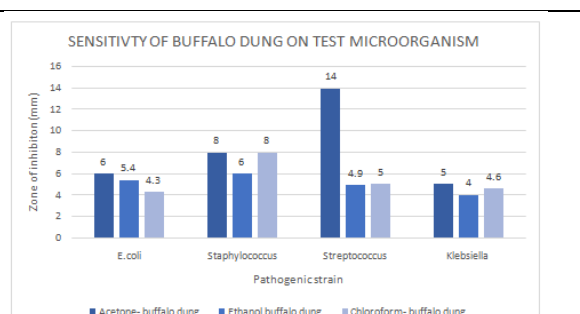


Figure 2: Graph showing the activity of buffalo dung extracts (zone of inhibition in mm) on test organisms.



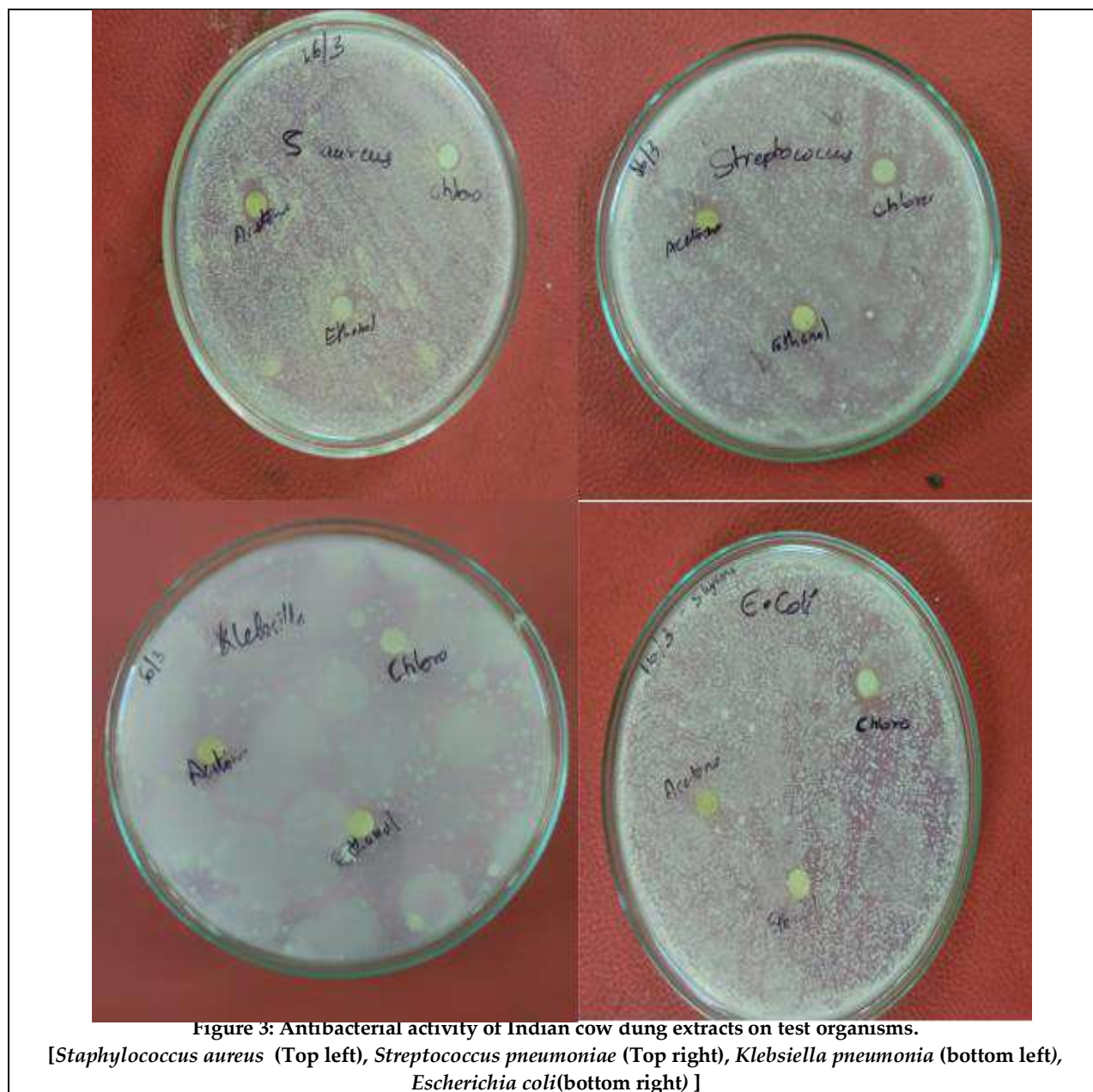


Figure 3: Antibacterial activity of Indian cow dung extracts on test organisms.

[*Staphylococcus aureus* (Top left), *Streptococcus pneumoniae* (Top right), *Klebsiella pneumoniae* (bottom left), *Escherichia coli* (bottom right)]



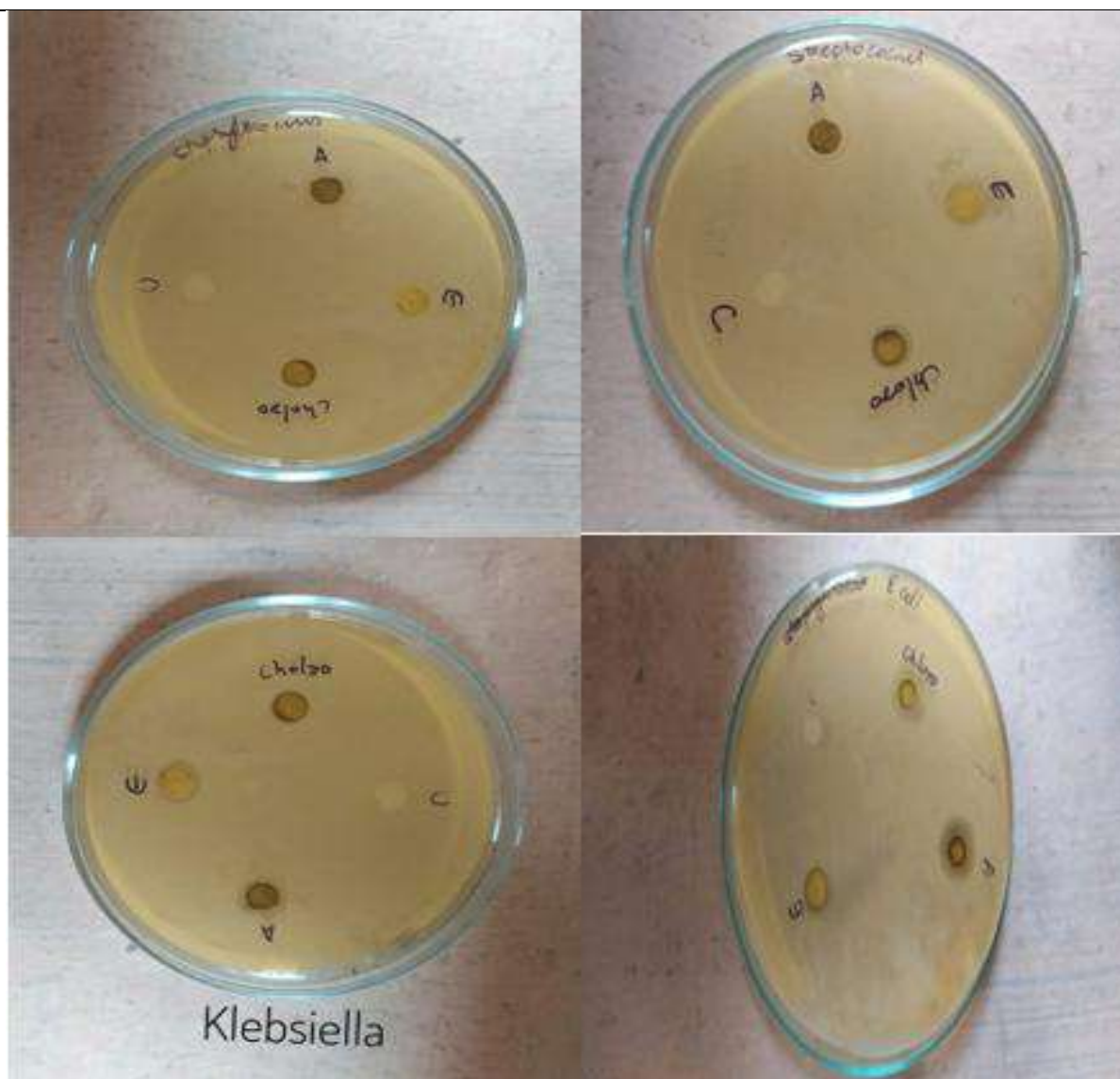


Figure 4: Antimicrobial activity of buffalo dung extracts on test organisms.

[*Staphylococcus aureus* (Top left), *Streptococcus pneumoniae* (Top right), *Klebsiella pneumoniae* (bottom left), *Escherichia coli* (bottom right)]





On $ab^*g\alpha$ - Continuous and Irresolute Functions in Topological Spaces

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ABSTRACT

The at most goal of this paper is to initiate a notion of $ab^*g\alpha$ - continuous function. We investigate the relation of $ab^*g\alpha$ - continuous function with other existing continuous function. Consequently, we define $ab^*g\alpha$ - irresolute function in topological spaces. Furthermore, we derived the relationship between $ab^*g\alpha$ - irresolute function and continuous function. Eventually, we define $ab^*g\alpha$ - homeomorphism and $ab^*g\alpha C$ - homeomorphism and few theorems are derived to illustrate the comparison between $ab^*g\alpha$ - continuous, $ab^*g\alpha$ - irresolute function and $ab^*g\alpha$ - homeomorphism.

Keywords: $ab^*g\alpha$ - closed, $ab^*g\alpha$ - continuous, $ab^*g\alpha$ - irresoluteness, $ab^*g\alpha$ - homeomorphism, $ab^*g\alpha C$ - homeomorphism

AMS subject classification: 54C05, 54C10.

INTRODUCTION

N. Levine [9] developed idea of g - closed sets and g - continuous functions in topological spaces. H. Maki et. Al [11] established $g\alpha$ - closed sets. M. Vigneshwaran and R. Devi [15] proposed the idea of $^*g\alpha$ - closed sets and $^*g\alpha$ -continuous. . M. Vigneshwaran and S. Saranya[16] introduced the concepts of $b^*g\alpha$ - closed sets and functions. K. Suthi Keerthana et.al [17] studied the concept of $ab^*g\alpha$ - closed sets. In this article, we initiate $ab^*g\alpha$ - continuous function using $ab^*g\alpha$ - closed sets. Further we define $ab^*g\alpha$ - irresolute function and $ab^*g\alpha$ - homeomorphism.





Preliminaries

Definition 2.1 A subset E of (S, τ) is called $ab^*g\alpha$ - closed set [17] if $\alpha cl(E) \subseteq V$ whenever $E \subseteq V$ and V is $b^*g\alpha$ - open in (S, τ) .

Definition 2.2 A space (S, τ) is called $T_{ab^*g\alpha}$ -space [18] if every $ab^*g\alpha$ - closed set is closed.

The basic definitions which are used in the next section are referred from the references

[1], [3], [4], [5], [6], [7], [8], [9], [11], [12], [13], [14], [15], [16].

Notation For a space (S, τ) , $C(S, \tau)$ (resp. $SC(S, \tau)$, $\alpha C(S, \tau)$, $GC(S, \tau)$, $GSC(S, \tau)$, $GPC(S, \tau)$, $SGC(S, \tau)$, $\alpha GC(S, \tau)$, $G\alpha C(S, \tau)$, $^*G\alpha C(S, \tau)$, $GSPC(S, \tau)$, $G^*SPC(S, \tau)$, $G^*C(S, \tau)$, $^*\alpha G\alpha C(S, \tau)$, $S^*G\alpha C(S, \tau)$, $B^*G\alpha C(S, \tau)$, $\alpha B^*G\alpha C(S, \tau)$) denoted as closed (resp. semi- closed, α - closed, g - closed, gs - closed, gp - closed, sg - closed, αg - closed, $g\alpha$ - closed, $^*g\alpha$ - closed, gsp - closed, g^*sp - closed, g^* - closed, $^*\alpha g\alpha$ - closed, $s^*g\alpha$ - closed, $b^*g\alpha$ - closed, $ab^*g\alpha$ - closed) subsets of (S, τ) and CS , CF , TS denotes the closed sets, continuous function and topological spaces resp.

3. $ab^*g\alpha$ - continuity and irresoluteness

Definition 3.1 A function $j: (S, \tau) \rightarrow (K, \zeta)$ is called $ab^*g\alpha$ - continuous if $j^{-1}(w)$ is a $ab^*g\alpha$ - closed set of (S, τ) for every closed set W of (K, ζ) .

Theorem 3.2 Every continuous function is $ab^*g\alpha$ - continuous function.

Proof Let W be a CS in (K, ζ) . Since, j is CF , $j^{-1}(w)$ is a CS in (S, τ) . But every CS is $ab^*g\alpha$ - CS .

$\therefore j^{-1}(w)$ is $ab^*g\alpha$ - CS in (S, τ) .

\therefore Every CF is $ab^*g\alpha$ - CF .

Reverse implication need not be true.

Example 3.3 Let $S = \{q_1, q_2, q_3\} = K$. $\tau = \{S, \phi, \{q_1\}, \{q_1, q_2\}\}$

$\zeta = \{K, \phi, \{q_1, q_2\}\}$, $\alpha B^*G\alpha C(S, \tau) = \{S, \phi, \{q_2\}, \{q_3\}, \{q_2, q_3\}\}$.

Suppose $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_2$, $j(q_2) = q_3$, $j(q_3) = q_1$.

$\therefore j$ is $ab^*g\alpha$ - continuous but not continuous.

Since, $j^{-1}(\{q_3\}) = \{q_2\}$ is $ab^*g\alpha$ - closed but not closed in (S, τ) .

Theorem 3.4

(1) Every α - CF is $ab^*g\alpha$ - CF .

(2) Every $^*g\alpha$ - CF is $ab^*g\alpha$ - CF .

Proof Let W be a CS in (K, ζ) . Since, j is α - CF , $j^{-1}(w)$ is a α - CS in (S, τ) . But every α - CS is $ab^*g\alpha$ - CS .

Hence $j^{-1}(w)$ is $ab^*g\alpha$ - CS in (S, τ) .

\therefore Every α - CF is $ab^*g\alpha$ - CF .

Proof of (2) is clear.

Reverse implication need not be true.

Example 3.5 Let $S = \{q_1, q_2, q_3\} = K$. $\tau = \{S, \phi, \{q_1\}, \{q_2, q_3\}\}$

$\zeta = \{K, \phi, \{q_1, q_2\}\}$, $\alpha C(S, \tau) = \{S, \phi, \{q_1\}, \{q_2, q_3\}\} = ^*G\alpha C(S, \tau)$,

$\alpha B^*G\alpha C(S, \tau) = \{S, \phi, \{q_1\}, \{q_2\}, \{q_3\}, \{q_1, q_2\}, \{q_2, q_3\}, \{q_1, q_3\}\}$.

Let $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_2$, $j(q_2) = q_3$, $j(q_3) = q_1$.

$\therefore j$ is $ab^*g\alpha$ - CF but not α - CF and $^*g\alpha$ - CF

Since, $j^{-1}(\{q_3\}) = \{q_2\}$ is $ab^*g\alpha$ - closed but not α -closed and $^*g\alpha$ - closed in (S, τ) .

Theorem 3.6

(1) Every $ab^*g\alpha$ - CF is gs - CF .

(2) Every $ab^*g\alpha$ - CF is gp - CF .

(3) Every $ab^*g\alpha$ - CF is gsp - CF .

(4) Every $ab^*g\alpha$ - CF is g^*sp - CF .





Proof Let W be a CS in (K, ζ) . Since, j is $ab^*g\alpha$ -CF, $j^{-1}(w)$ is a $ab^*g\alpha$ -CS in (S, τ) . But every $ab^*g\alpha$ -CS is gs -CS. Hence $j^{-1}(w)$ is gs -CS in (S, τ) . $\therefore j$ is gs -continuous.

Proof of (2) to (4) is clear.

Reverse implication need not be true.

Example 3.7 Let $S = \{q_1, q_2, q_3\} = K$. $\tau = \{S, \phi, \{q_3\}, \{q_1, q_2\}\}$
 $\zeta = \{K, \phi, \{q_1\}, \{q_2\}, \{q_1, q_2\}\}$, $\alpha B^*G\alpha C(S, \tau) = \{S, \phi, \{q_3\}, \{q_1, q_2\}\}$,
 $GS, GP, GSP, G^*SPC(S, \tau) = \{S, \phi, \{q_1\}, \{q_2\}, \{q_3\}, \{q_1, q_2\}, \{q_2, q_3\}, \{q_1, q_3\}\}$.

Let $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_2, j(q_2) = q_3, j(q_3) = q_1$.

$\therefore jgs, gp, gsp, g^*sp$ -CF is but not $ab^*g\alpha$ -CF.

Since, $j^{-1}(\{q_3\}) = \{q_2\}$ is gs, gp, gsp, g^*sp -closed but not $ab^*g\alpha$ -closed in (S, τ) .

Theorem 3.8

- (1) Every $ab^*g\alpha$ -CF is sg -CF.
- (2) Every $ab^*g\alpha$ -CF is αg -CF.
- (3) Every $ab^*g\alpha$ -CF is $^* \alpha g\alpha$ -CF.
- (4) Every $ab^*g\alpha$ -CF is $s^*g\alpha$ -CF.
- (5) Every $ab^*g\alpha$ -CF is $b^*g\alpha$ -CF.

Proof Let W be a CS in (K, ζ) . Since, j is $ab^*g\alpha$ -CF, $j^{-1}(w)$ is a $ab^*g\alpha$ -CS in (S, τ) . But every $ab^*g\alpha$ -CS is sg -CS. Hence $j^{-1}(w)$ is sg -CS in (S, τ) . $\therefore j$ is sg -continuous.

Proof of (2) to (5) is obvious.

Reverse implication need not be true.

Example 3.9 Let $S = \{q_1, q_2, q_3\} = K$. $\tau = \{S, \phi, \{q_3\}\}$

$\zeta = \{K, \phi, \{q_2\}\}$, $\alpha B^*G\alpha C(S, \tau) = \{S, \phi, \{q_1\}, \{q_2\}, \{q_1, q_2\}\}$,

$SG, \alpha G, ^* \alpha G\alpha, S^*G\alpha, B^*G\alpha C(S, \tau) = \{S, \phi, \{q_1\}, \{q_2\}, \{q_1, q_2\}, \{q_2, q_3\}, \{q_1, q_3\}\}$.

Let $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_2, j(q_2) = q_3, j(q_3) = q_1$.

$\therefore jsg, \alpha g, ^* \alpha g\alpha, s^*g\alpha, b^*g\alpha$ -CF is but not $ab^*g\alpha$ -CF.

Since, $j^{-1}(\{q_1, q_3\}) = \{q_2, q_3\}$ is $sg, \alpha g, ^* \alpha g\alpha, s^*g\alpha, b^*g\alpha$ -closed but not $ab^*g\alpha$ -closed in (S, τ) .

Remark 3.10 Every $ab^*g\alpha$ -CF is independent of g -continuity and g^* -continuity.

Example 3.11 Let $S = \{q_1, q_2, q_3\} = K$. $\tau = \{S, \phi, \{q_1\}, \{q_1, q_2\}\}$

$\zeta = \{K, \phi, \{q_2\}, \{q_2, q_3\}\}$. Define $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_3, j(q_2) = q_2, j(q_3) = q_1$.

$GC(S, \tau) = \{S, \phi, \{q_3\}, \{q_2, q_3\}, \{q_1, q_3\}\} = G^*C(S, \tau)$,

$\alpha B^*G\alpha C(S, \tau) = \{S, \phi, \{q_2\}, \{q_3\}, \{q_2, q_3\}\}$.

Here $j^{-1}(\{q_1, q_3\}) = \{q_1, q_3\}$ is not $ab^*g\alpha$ -closed in (S, τ) . Therefore, j is not $ab^*g\alpha$ -CF. However j is g -CF and g^* -CF.

Example 3.12 Let $S = \{q_1, q_2, q_3\} = K$. $\tau = \{S, \phi, \{q_1\}, \{q_1, q_2\}\}$

$\zeta = \{K, \phi, \{q_1\}, \{q_2, q_3\}\}$. Define $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_2, j(q_2) = q_1, j(q_3) = q_3$.

$GC(S, \tau) = \{S, \phi, \{q_3\}, \{q_2, q_3\}, \{q_1, q_3\}\} = G^*C(S, \tau)$,

$\alpha B^*G\alpha C(S, \tau) = \{S, \phi, \{q_1\}, \{q_3\}, \{q_1, q_3\}\}$.

Here $j^{-1}(\{q_1\}) = \{q_2\}$ is not g -closed and g^* -closed in (S, τ) . Therefore, j is not g -CF and g^* -CF. However j is $ab^*g\alpha$ -CF.

Remark 3.13 The composition of two $ab^*g\alpha$ -CF need not be a $ab^*g\alpha$ -CF.

The proof follows from the following example.

Example 3.14 Let $S = \{q_1, q_2, q_3\} = K = L$. $\tau = \{S, \phi, \{q_1\}, \{q_1, q_2\}\}$

$\zeta = \{K, \phi, \{q_1, q_2\}\}$, $\eta = \{L, \phi, \{q_2\}, \{q_2, q_3\}\}$





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Define $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_1, j(q_2) = q_2, j(q_3) = q_3$.

Define $g: (K, \zeta) \rightarrow (L, \eta)$ such that $g(q_1) = q_3, g(q_2) = q_2, g(q_3) = q_1$.

$\alpha B^*GaC(S, \tau) = \{S, \phi, \{q_2\}, \{q_3\}, \{q_2, q_3\}\}$, $\alpha B^*GaC(L, \eta) = \{L, \phi, \{q_1\}, \{q_3\}, \{q_1, q_3\}\}$.

Here $\{q_1, q_3\}$ is a CS in (L, η) . But $(g \circ j)^{-1}(\{q_1, q_3\}) = \{q_1, q_3\}$ is not αb^*ga -closed in (S, τ) .

$\therefore (g \circ j)$ is not αb^*ga -CF.

Definition 3.15 A function $j: (S, \tau) \rightarrow (K, \zeta)$ is called αb^*ga -irresolute if $j^{-1}(w)$ is a αb^*ga -closed set of (S, τ) for every αb^*ga -closed set W of (K, ζ) .

Theorem 3.16 Every αb^*ga -irresolute is αb^*ga -CF.

Proof Let W be a CS in (K, ζ) . Since, every CS is αb^*ga -CS.

$\therefore W$ is αb^*ga -CS of (K, ζ) .

Since j is αb^*ga -irresolute, $j^{-1}(w)$ is αb^*ga -CS in (S, τ) . Thus j is αb^*ga -CF.

Reverse implication need not be true.

Example 3.17 Let $S = \{q_1, q_2, q_3\} = K$. $\tau = \{S, \phi, \{q_2\}, \{q_2, q_3\}\}$

$\zeta = \{K, \phi, \{q_1, q_2\}\}$. Define $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_3, j(q_2) = q_1, j(q_3) = q_2$.

$\alpha B^*GaC(S, \tau) = \{S, \phi, \{q_1\}, \{q_3\}, \{q_1, q_3\}\}$.

$\alpha B^*GaC(K, \zeta) = \{K, \phi, \{q_1\}, \{q_2\}, \{q_1, q_2\}, \{q_2, q_3\}, \{q_1, q_3\}\}$.

Since $\{q_1, q_3\}$ is αb^*ga -CS in (K, ζ) but $j^{-1}\{q_1, q_3\} = \{q_1, q_2\}$ is αb^*ga -CS in (S, τ) .

Therefore, j is not αb^*ga -irresolute.

However, j is αb^*ga -CF.

Theorem 3.18 Let (S, τ) be any topological space and (K, ζ) be a $T_{\alpha b^*ga}$ -space and

$j: (S, \tau) \rightarrow (K, \zeta)$ be a function. Then the following are equivalent.

(i) j is αb^*ga -irresolute.

(ii) j is αb^*ga -continuous.

Proof

(i) \Rightarrow (ii) Let W be a CS of (K, ζ) . Since every CS is αb^*ga -CS in (K, ζ) . Since j is αb^*ga -irresolute, $j^{-1}(w)$ is αb^*ga -CS in (S, τ) . Hence j is αb^*ga -CF.

(ii) \Rightarrow (i) Let W be a αb^*ga -CS of (K, ζ) . Since (K, ζ) is a $T_{\alpha b^*ga}$ -space, W is closed in (K, ζ) and j is αb^*ga -CF, $j^{-1}(W)$ is αb^*ga -CS in (S, τ) . Hence j is αb^*ga -irresolute.

Theorem 3.19 Let $j: (S, \tau) \rightarrow (K, \zeta)$ and $g: (K, \zeta) \rightarrow (L, \eta)$ be any two functions. Then

(i) $(g \circ j): (S, \tau) \rightarrow (L, \eta)$ is αb^*ga -continuous if g is continuous and h is αb^*ga -continuous.

(ii) $(g \circ j): (S, \tau) \rightarrow (L, \eta)$ is αb^*ga -irresolute if both g and j are αb^*ga -irresolute.

(iii) $(g \circ j): (S, \tau) \rightarrow (L, \eta)$ is αb^*ga -continuous if g is αb^*ga -continuous and j is αb^*ga -irresolute.

Proof

(i) Let W be a CS of (L, η) . Since j is CF, $j^{-1}(W)$ is CS in (K, ζ) . Since j is αb^*ga -continuous, $(g \circ j)^{-1}(W) = j^{-1}(g^{-1}(W))$ is αb^*ga -CS in (S, τ) . Therefore, $(g \circ j)$ is αb^*ga -continuous.

(ii) Let W be a αb^*ga -CS of (L, η) . Since g is αb^*ga -irresolute, $g^{-1}(W)$ is αb^*ga -CS in (K, ζ) . Since j is αb^*ga -irresolute, $(g \circ j)^{-1}(W) = j^{-1}(g^{-1}(W))$ is αb^*ga -CS in (S, τ) . Therefore, $(g \circ j)$ is αb^*ga -irresolute.

(iii) Let W be a αb^*ga -CS of (L, η) . Since g is αb^*ga -continuous, $g^{-1}(W)$ is αb^*ga -CS in (K, ζ) . Since j is αb^*ga -irresolute, $(g \circ j)^{-1}(W) = j^{-1}(g^{-1}(W))$ is αb^*ga -CS in (S, τ) . Therefore, $(g \circ j)$ is αb^*ga -irresolute.



 **$ab^*g\alpha$ - Homeomorphism**

Definition 4.1 A function $j: (S, \tau) \rightarrow (K, \zeta)$ is called $ab^*g\alpha$ - open if the image $j(W)$ is $ab^*g\alpha$ - open in (K, ζ) for every open set of (S, τ) .

Definition 4.2 A function $j: (S, \tau) \rightarrow (K, \zeta)$ is called $ab^*g\alpha$ - closed if the image $j(W)$ is $ab^*g\alpha$ - closed in (K, ζ) for every closed set of (S, τ) .

Definition 4.3 A function $j: (S, \tau) \rightarrow (K, \zeta)$ is called $ab^*g\alpha$ - homeomorphism if j is bijective and j and j^{-1} are $ab^*g\alpha$ - continuous.

Definition 4.4 A function $j: (S, \tau) \rightarrow (K, \zeta)$ is called $ab^*g\alpha C$ - homeomorphism if j is bijective and j and j^{-1} are $ab^*g\alpha$ - irresolute.

Theorem 4.5 Every open function is $ab^*g\alpha$ - open.

Proof Let E be an open set in (S, τ) . Since j is open function, $j(E)$ is open in (K, ζ) . But every open set is $ab^*g\alpha$ - open set. Therefore, $j(E)$ is $ab^*g\alpha$ - open in (K, ζ) . Hence j is $ab^*g\alpha$ - open function.

Reverse implication need not be true.

Example 4.6 Let $S = \{q_1, q_2, q_3\} = K$. $\tau = \{S, \phi, \{q_1, q_2\}\}$

$\zeta = \{K, \phi, \{q_1\}\}$. Define $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_2$, $j(q_2) = q_1$, $j(q_3) = q_3$.

$ab^*G\alpha C(K, \zeta) = \{K, \phi, \{q_1\}, \{q_1, q_2\}, \{q_1, q_3\}\}$.

Here $j\{q_1, q_2\} = \{q_1, q_2\}$ is $ab^*g\alpha$ - open in (K, ζ) .

Therefore, j is $ab^*g\alpha$ - open function. However, it is not a open function because $j\{q_1, q_2\}$ is not open in (K, ζ) .

Theorem 4.7 Every homeomorphism is $ab^*g\alpha$ - homeomorphism.

Proof Let $j: (S, \tau) \rightarrow (K, \zeta)$ be a homeomorphism. Since j is homeomorphism, j is bijective and also j is both open and continuous. Since every open function is $ab^*g\alpha$ - open and every CF is $ab^*g\alpha$ - CF, j is bijective, $ab^*g\alpha$ - open and $ab^*g\alpha$ - continuous. Hence j is $ab^*g\alpha$ - homeomorphism.

Reverse implication need not be true.

Example 4.8 Let $S = \{q_1, q_2, q_3\} = K$. $\tau = \{S, \phi, \{q_1, q_2\}\}$

$\zeta = \{K, \phi, \{q_1\}\}$. Define $j: (S, \tau) \rightarrow (K, \zeta)$ such that $j(q_1) = q_1$, $j(q_2) = q_2$, $j(q_3) = q_3$.

$ab^*G\alpha C(S, \tau) = \{S, \phi, \{q_1\}, \{q_3\}, \{q_1, q_3\}\}$.

$ab^*G\alpha C(K, \zeta) = \{K, \phi, \{q_1\}, \{q_2\}, \{q_1, q_2\}, \{q_2, q_3\}, \{q_1, q_3\}\}$.

Then j is $ab^*g\alpha$ - homeomorphism but not homeomorphism. Since $\{q_1, q_2\}$ is open in (S, τ) but the image is not open in (K, ζ) .

Theorem 4.9 Let $j: (S, \tau) \rightarrow (K, \zeta)$ be a bijective and $ab^*g\alpha$ - CF, then the following are equivalent.

- (i) j is $ab^*g\alpha$ - open function,
- (ii) j is $ab^*g\alpha$ - homeomorphism,
- (iii) j is $ab^*g\alpha$ - closed function.

Proof (i) \Rightarrow (ii) Suppose j is $ab^*g\alpha$ - open function, then j is bijective and $ab^*g\alpha$ - CF. By definition of $ab^*g\alpha$ - homeomorphism, j is $ab^*g\alpha$ - homeomorphism.

(ii) \Rightarrow (iii) Since j is $ab^*g\alpha$ - homeomorphism, j is bijective and also j is $ab^*g\alpha$ - open and $ab^*g\alpha$ - continuous. Let j be a CS of (S, τ) . Then j^c is open set in (S, τ) . Since j is $ab^*g\alpha$ - open function, $j(j^c)$ is $ab^*g\alpha$ - open in (K, ζ) . Thus, $j(j^c) = (j(j))^c$ is $ab^*g\alpha$ - open set in (K, ζ) . Thus, $j(j)$ is $ab^*g\alpha$ - CS in (K, ζ) . Hence j is $ab^*g\alpha$ - closed function.

(iii) \Rightarrow (i) Suppose that j is $ab^*g\alpha$ - closed function. Let E be a CS in (S, τ) . Since j is $ab^*g\alpha$ - closed function, $j(E)$ is $ab^*g\alpha$ - CS in (K, ζ) . Hence $j(E) = (j^{-1})^{-1}(E)$ is $ab^*g\alpha$ - CS in (K, ζ) which implies j^{-1} is $ab^*g\alpha$ - CF on (K, ζ) . By hypothesis, j is $ab^*g\alpha$ - open function.





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Grid-Tied PV Power Generation System Inertia and Damping Analysis with DC Voltage Droop Control

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ABSTRACT

Since power electronics are required for solar electricity production, it lacks the intrinsic characteristics of natural inertia and damping. In order to contribute the capacitance of the medium scale to the utility, this paper builds the static synchronous generator of the grid-integrated PV system with DC voltage regulation as its research topic. The system's inertia, synchronization, and damping characteristics, as well as the laws driving these factors, are examined using the model. The medium-term energy storage capacity of the capacitor may lead to a system with particular inertia properties. When the coefficient of drooping D_p decreases, the system exhibits a stronger inertia characteristic from the standpoint of the control parameters. The damping consequence of the arrangement is increased when K_p , the DC voltage external circle proportional coefficient, is increased. The system's synchronization ability improves with an increase in the DC voltage external loop fundamental constant K_i . MATLAB/Simulink simulations are also used to ensure that the theoretical analysis findings are valid before they can be implemented

Keywords: consequence, Simulink, System, inertia, natural



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INTRODUCTION

As the global energy crisis and ecological degradation deepen, the rapid advancement of green energy has emerged as the worldwide consensus for development. This is a result of the ongoing global energy catastrophe and ecological degradation. The generation of renewable energy, FACTS devices, and electric vehicles have all advanced significantly in recent years [1]. Grid-connected photovoltaic energy generation has experienced rapid growth as a type of green energy generating technology as a result of the numerous property and pollution-free advantages it provides. [2]. The main source of power production in the traditional system is the Rotating Synchronous Generator (RSG). RSG are distinguished by their superior damping and high levels of intrinsic inertia. Due to the fact that the grid-tied inverter is an electrical device, it lacks all quantifiable inertia [3]. It is connected to the utility on a large scale with the peculiarity of little inertia and pitiful damping, which causes a decrease in the inertia of the system and poses significant challenges to the reliable and secure operation of the grid [4]. In contrast, photovoltaic power generation is characterized by a high level of volatility, an elevated level of unpredictability, and an obvious intermittent entity, all of which will negatively affect the grid's dependable operation. Additionally, the enormous potential that the main energy and its converter have in simulating inertia and damping is unique [5]. The DC side capacitor of the grid-tied inverter has features of dynamic behavior that are comparable to those of the RSG rotor, and its capacitor voltage can fluctuate within a certain range, offering some inertia support [6]. However, the synchronization, damping, and inertia uniqueness of the overall scheme, together with the dynamics of the capacitor, were not examined in this work [7-10]. This paper demonstrates how specific adjustments to conventional control strategies may also affect the system's inertia and damping characteristics.

TEST SYSTEM UNDER IMPLEMENTATION

The building of the grid-connected PV-producing system, complete with DC voltage droop regulation, is shown in Figure 1. The system's three main parts are the solar module, the direct current-to-direct current converter, and the grid-integrated inverter. The DC/DC boost converter uses the MPPT controller, and by creating a frequency difference based on the voltage external loop and the internal current loop, the inverter side creates the DC voltage droop control.

PROPOSED CONTROLLERS UNDER IMPLEMENTATION

Because the output voltage of PV modules cannot meet the requirements of the network voltage category, a DC/DC boost converter is required to increase the yield voltage of a PV system. The grid-tied inverter can then be connected to the grid after the DC/DC boost converter has been installed. The grid-integrated PV inverter must provide the power system with a good degree of inertia support if the utility's frequency changes in order for the system to quickly regain its power balance. In actuality, the MPPT of the PV system is much less than the utility's demand in the context of the operation of PV-integrated grids. Therefore, to satisfy this need, the PV-producing station regularly provides the maximum power, and the DC/DC converter adopts the MPPT to be in charge of it. An illustration of the boost converter's control block is shown in Figure 2. The diagram is displayed below. The grid-connected inverter uses a double closed-loop control system, consisting of an external DC voltage loop and an internal current loop, to realize the capacitor's voltage stability. Even when there is a slight disturbance, the utility-integrated converter still favors the DC/DC converter since it generates the most power. A frequency deviation must be incorporated into the often double-closed control loops in order to give the DC control seen in Figure 3 since the decoupling relationship cannot respond to changes in the grid frequency.

SIMULATION RESULTS AND DISCUSSION

The damping, inertia, and synchronization uniqueness of the system are analyzed by providing the system SSG representation. This paper suggests utility associated PV system control approach that is depending on the DC voltage control. The control strategy is intended to be used in the view of less conflict and does not involve the addition of new hardware equipment.



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CONCLUSION

According to the findings of the study, the following statements are true, when looking at organize limitation, the inertia characteristic of the arrangement is stronger when the droop coefficient D_p is smaller; the damping effect of the system is efficient when the DC voltage outer loop proportional coefficient K_p is larger; and the DC voltage outer loop integral value is greater when the DC voltage outer loop proportional coefficient K_p is larger. When the DC voltage droop control technique is implemented, the DC side capacitor of the system is able to display the inertia characteristics, and the system is able to run reliably in spite of the presence of even relatively minor disturbances. The findings presented in this research paper have the potential to improve the frequency stability of photovoltaic power generation systems that are grid-connected, even in the presence of relatively minor disturbances, and to provide a theoretical basis for the environmentally responsible incorporation of photovoltaic power generation into power grids.

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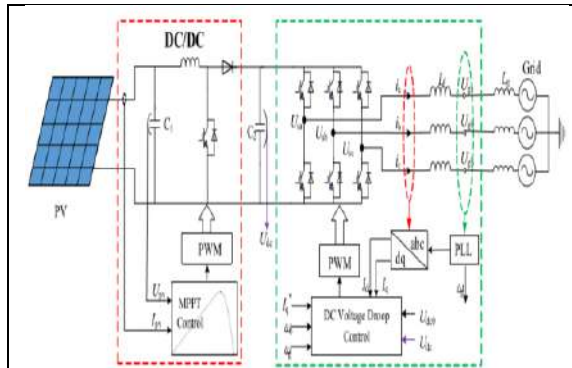


Figure.1: Test system under implementation

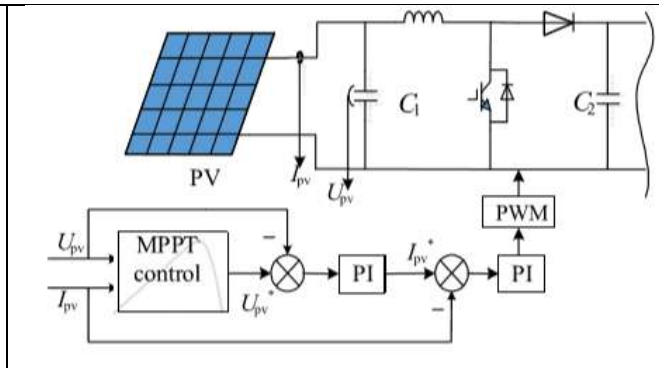


Figure.2: Controller for DC/DC converter

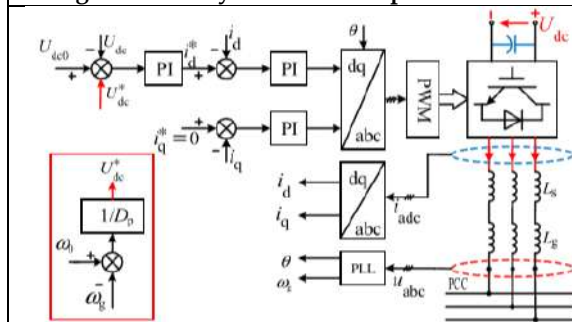


Figure.3: Controller implementation for inverter

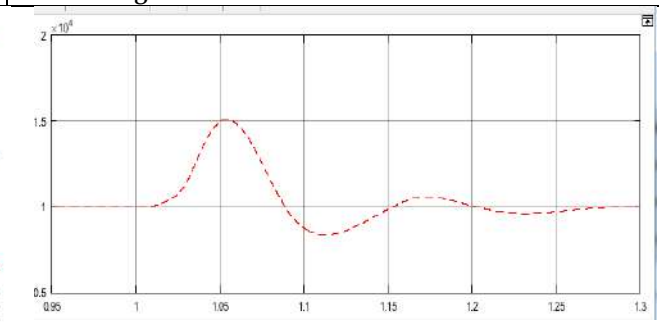


Figure 4: With the droop Pe

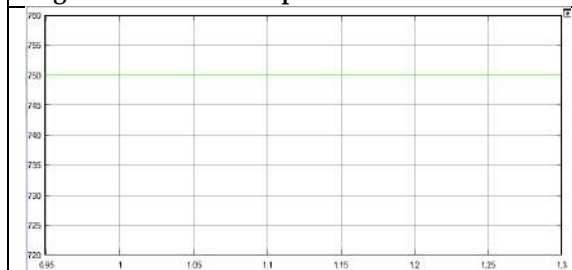


Figure 4: Vdc

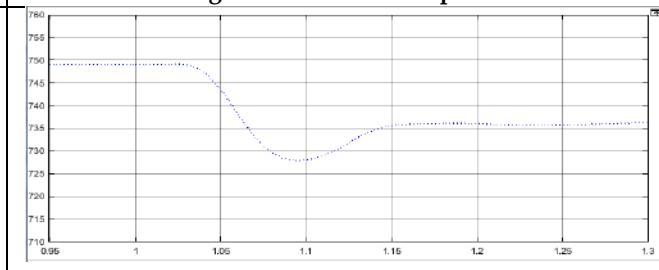


Figure 5: Without droop At DP=60 Pe

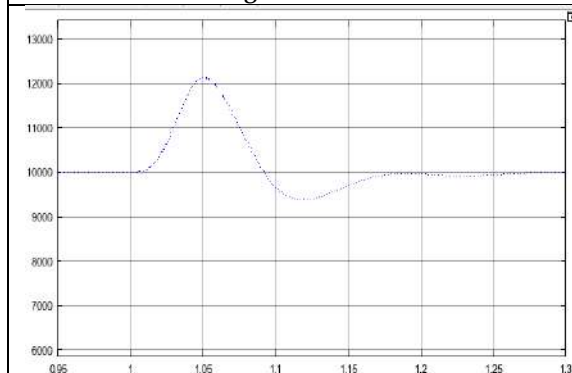
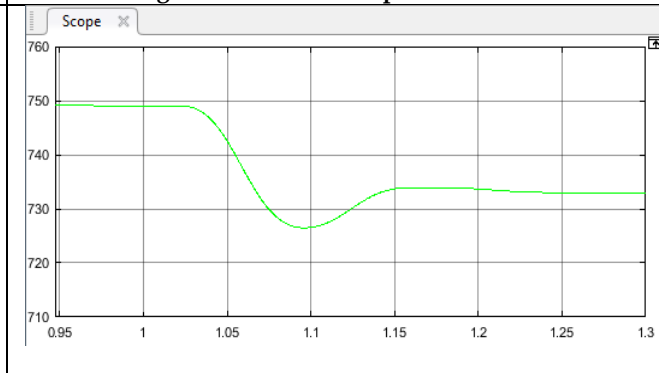


Figure 5: Vdc

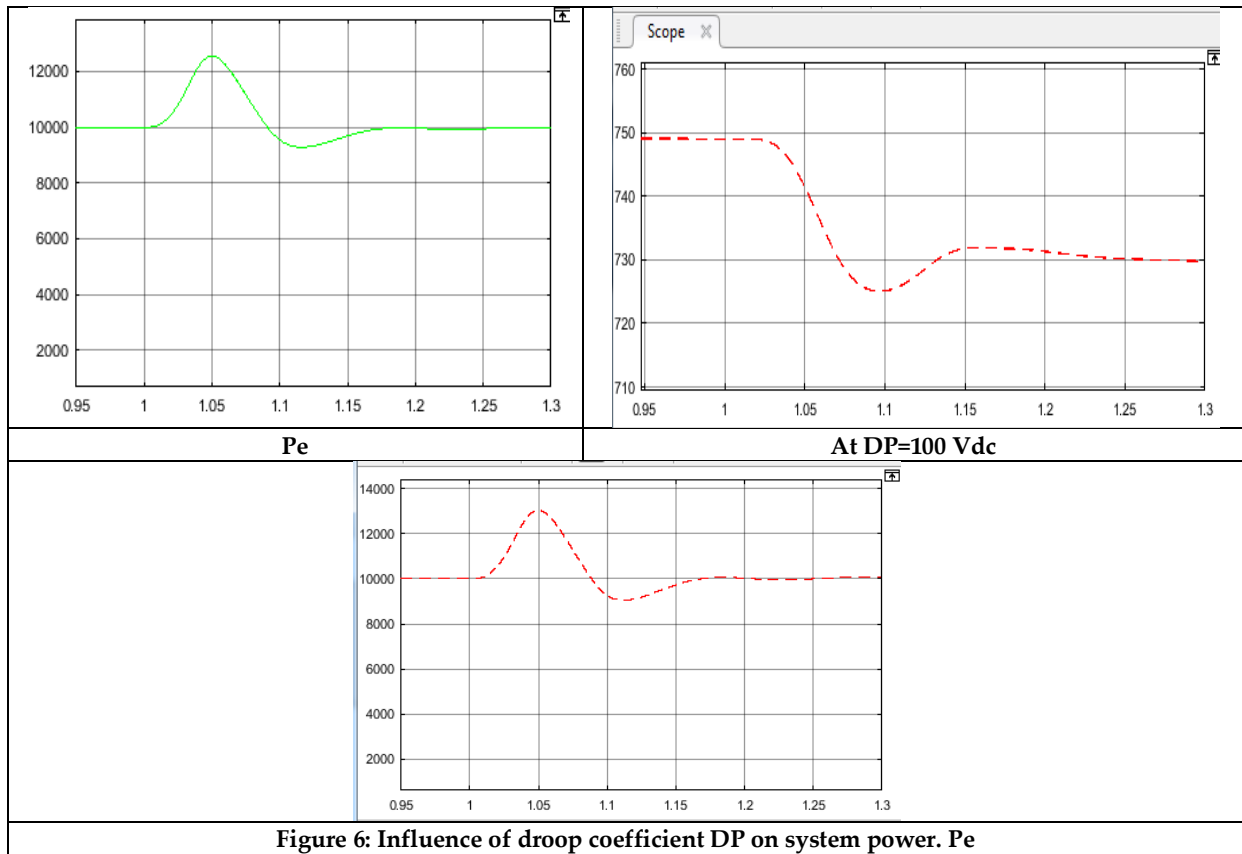


Vdc At DP=80





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On Soft Generalized** - Connectedness in Soft Topological Spaces

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ABSTRACT

The aim of this paper is to introduce the concept of soft generalized** (briefly soft g^{**}) - connectedness and soft generalized** disconnected space in soft topological spaces. And we study the relation of this new type of soft connectedness with existing soft connectedness also we discuss some of their properties.

Keywords : soft g^{**} - separated Sets, soft g^{**} - connected Space, soft g^{**} - disconnected space.

INTRODUCTION

The researchers introduced the concept of soft sets to solve the complicated real life problems in engineering, economics, medicine, sociology, several theories like fuzzy set theory [1] and other fields. The basic notion of soft set theory was introduced in the year 1999 [2]. Shabir and Naz [3] formulated the idea of soft topological spaces. Hussain and Ahmed [4] investigated the properties of soft topological spaces. J.R. Porter and R.G.Woods, introduced the concept of subspaces of connected spaces [5]. Later some of the researchers defined and studied the properties of soft connected space in soft topological spaces [6] And In 2021 Savita Rathee & Ridam Girdhar [7] introduced soft ω -connectedness in soft topological spaces. In this paper we defined soft generalized**-connectedness in soft topological spaces and investigated some of their characteristics.

PRELIMINARIES

DEFINITION : 2.1 [8]

- (i) A soft set F_A on the universe U is defined by the set of ordered pairs, E be the set of parameters and $A \subseteq E$, then $F_A = \{(x, f_A(x)) : x \in E\}$ where $f_A : E \rightarrow P(U)$ such that $f_A(x) = \emptyset$ if $x \notin A$. Here the value of $f_A(x)$ may be

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arbitrary. Some of them may be empty some may have non-empty intersection. Note that the set of all soft sets with the parameter set E over U will be denoted by $S(U)$.

- (ii) Let $F_A \in S(U)$. If $f_A(x) = \emptyset$ for all $x \in A$ then F_A is called an empty soft set, denoted by F_\emptyset .
- (iii) Let $F_A \in S(U)$. If $F_A(x) = U$ for all $x \in A$ then F_A is called a A -universal soft set, denoted by F_A . If $A = E$, then the A -universal soft set is called universal soft set denoted by F_E .
- (iv) Let $F_A, F_B \in S(U)$. Then soft union $F_A \tilde{\cup} F_B$, soft intersection $F_A \tilde{\cap} F_B$, and soft difference $F_A \setminus F_B$ of F_A and F_B are defined by respectively.

$$f_{A \tilde{\cup} B}(x) = f_A(x) \cup f_B(x), f_{A \tilde{\cap} B}(x) = f_A(x) \cap f_B(x), f_{A \setminus B}(x) = f_A(x) \setminus f_B(x),$$

and the soft complement F_A^c of F_A is defined by $f_A^c(x) = f_A^c$ where $f_A^c(x)$ is complement of the set $f_A(x)$, that is $f_A^c(x) = U \setminus f_A(x)$ for all $x \in E$.

- (v) Let $F_A \in S(U)$. The relative complement of F_A is denoted by F_A' and is defined by $(F_A)' = (F_A')$ where $F_A': A \rightarrow P(U)$ is a mapping given by $(F_\alpha)' = U \setminus F_\alpha$ for all $\alpha \in A$.
- (vi) Let $F_A \in S(U)$. A soft topology on F_A denoted by $\tilde{\tau}$, is a collection of soft subsets of F_A having following conditions.
 - $F_A, F_\emptyset \in \tilde{\tau}$.
 - The union of any number of soft sets in $\tilde{\tau}$ belongs to $\tilde{\tau}$.
 - The intersection of any two soft sets in $\tilde{\tau}$ belongs to $\tilde{\tau}$.

Then the pair $(F_A, \tilde{\tau})$ is called a soft topological space.

- (vii) Let $(F_A, \tilde{\tau})$ be a soft topological space, then every element of $\tilde{\tau}$ is called a soft open sets in $\tilde{\tau}$.
- (viii) Let $(F_A, \tilde{\tau})$ be a soft topological space. A soft set F_A is said to be a soft closed set, if its relative complement F_A' belongs to $\tilde{\tau}$.
- (ix) Let $(F_A, \tilde{\tau})$ be a soft topological space, then soft interior of soft set F_A is defined as the union of all soft open sets contained in F_A . It is denoted by $\text{int}(F_A)$.
- (x) Let $(F_A, \tilde{\tau})$ be a soft topological space, then soft closure of soft set F_A is defined as the intersection of all soft closed super sets containing in F_A . It is denoted by $\text{cl}(F_A)$.
- (xi) Let $(F_A, \tilde{\tau})$ be a soft topological space, $F_B \subseteq F_A$ and $\alpha \in F_B$. If there exists $F_C \in \tilde{\tau}$ such that $\alpha \in F_C \subseteq F_B$, then α is called a soft interior point of F_B and the collection of all soft-interior points of F_B , denoted by F_B^o is called soft interior of F_B .
- (xii) Let $(F_A, \tilde{\tau})$ be a soft topological space, $F_B \subseteq F_A$ and $\alpha \in F_A$. If there is a soft open set F_C such that $\alpha \in F_C \subseteq F_B$, then F_B is called soft neighbourhood of α . Set of all soft neighborhoods of α , denoted by $N(\alpha)$, is called family by soft neighborhoods of α , (ie) $N(\alpha) = \{F_C : F_C \in \tilde{\tau} \text{ and } \alpha \in F_C \subseteq F_B\}$ In particular, $V(\alpha) = \{F_C \in \tilde{\tau} : \alpha \in F_C\}$.

DEFINITION: 2.2 [7]

- (i) Two soft sets F_A and G_A are said to be soft disjoint if $F_A \cap G_A = \tilde{\emptyset}$.
- (ii) Let $(F_A, \tilde{\tau})$ be a soft topological space. Two non-null soft sets F_{A_1} and F_{A_2} are said to be soft separated sets if and $F_{A_1} \cap F_{A_2} = \emptyset$.
- (iii) A soft topological space $(F_A, \tilde{\tau})$ is called soft disconnected if $(F_A, \tilde{\tau}) = F_{A_1} \cup F_{A_2}$ such that $\text{cl}(F_{A_1}) \cap F_{A_2} = \emptyset$ and $F_{A_1} \cap \text{cl}(F_{A_2}) = \emptyset$. Otherwise the space is soft connected Space.

SOFT g^{} - SEPERATED SETS**

This section is to introduce the concept of soft g^{**} - seperated sets and study their properties.

DEFINITION: 3.1

Let F_{A_1} and F_{A_2} be two non-null soft sets in a soft topological Space $(F_A, \tilde{\tau})$ then F_{A_1} and F_{A_2} are soft g^{**} - seperated sets iff

$$sg^{**} \text{cl}(F_{A_1}) \cap F_{A_2} = \emptyset \text{ and } F_{A_1} \cap sg^{**} \text{cl}(F_{A_2}) = \emptyset$$



**EXAMPLE : 3.2**

Let $= \{a, b, c\}$, $E = \{e_1, e_2, e_3\}$

$A = \{e_1, e_2\} \subseteq E$

$F_A = \{(e_1, \{a, b\}), (e_2, \{c\})\}$

$F_{A_1} = \{(e_1, \{a\})\}$

$F_{A_2} = \{(e_1, \{b\})\}$

$F_{A_3} = \{(e_1, \{a, b\})\}$

$F_{A_4} = \{(e_1, \{a\}), (e_2, \{c\})\}$

$F_{A_5} = \{(e_1, \{b\}), (e_2, \{c\})\}$

$F_{A_6} = \{(e_2, \{c\})\}$

$F_{A_7} = F_A$

$F_{A_8} = F_\emptyset$

soft open sets of $\tilde{\tau} = \{F_A, F_\emptyset, F_{A_2}, F_{A_5}\}$

soft closed sets $= \{F_\emptyset, F_A, F_{A_1}, F_{A_4}\}$

soft g^{**} -closed sets are $= \{F_A, F_\emptyset, F_{A_1}, F_{A_3}, F_{A_4}\}$

soft g^{**} -open sets are $= \{F_A, F_\emptyset, F_{A_5}, F_{A_6}, F_{A_2}\}$

Consider two soft sets F_{A_3} and F_{A_6} .

$sg^{**}cl(F_{A_3}) = F_{A_3} \Rightarrow F_{A_3} \cap F_{A_6} = \emptyset$ and

$sg^{**}cl(F_{A_6}) = F_{A_4} \Rightarrow F_{A_3} \cap F_{A_4} = \emptyset$

$\Rightarrow F_{A_3}$ and F_{A_6} are soft g^{**} -separated sets.

THEOREM 3.3

Let F_{A_1} and F_{A_2} are soft g^{**} -separated sets in a soft topological space $(F_A, \tilde{\tau})$ then they are disjoint.

Proof:

Since F_{A_1} and F_{A_2} are soft g^{**} -separated sets.

$\Rightarrow sg^{**}(F_{A_1}) \cap F_{A_2} = \emptyset$ and $F_{A_1} \cap sg^{**}(F_{A_2}) = \emptyset$.

Now, $F_{A_1} \subseteq sg^{**}(F_{A_1})$ [since every soft closed set is soft g^{**} -closed set]

$\Rightarrow F_{A_1} \cap F_{A_2} \subseteq sg^{**}(F_{A_1}) \cap F_{A_2} = \emptyset \Rightarrow F_{A_1} \cap F_{A_2} = \emptyset$

$\Rightarrow F_{A_1}$ and F_{A_2} are disjoint Soft sets. The converse need not be true as seen from the following example.

EXAMPLE: 3.4

In the above example 3.2, we take F_{A_1} and F_{A_2} be the two soft sets over $(F_A, \tilde{\tau})$ (ie) $F_{A_1} = \{(e_1, \{a\})\}$, $F_{A_2} = \{(e_1, \{b\})\}$, then F_{A_1} and F_{A_2} are disjoint soft sets, but they are not soft g^{**} -separated sets. Since $sg^{**}cl(F_{A_1}) = F_{A_1}$ and $sg^{**}cl(F_{A_2}) = F_{A_4}$. So $sg^{**}cl(F_{A_1}) \cap F_{A_2} = \emptyset$, but $F_{A_1} \cap sg^{**}cl(F_{A_2}) = \emptyset$.

THEOREM: 3.5

Any two soft separated sets are soft g^{**} -separated sets.

Proof

Let F_{A_1} and F_{A_2} be two soft separated sets over $(F_A, \tilde{\tau})$ then $cl(F_{A_1}) \cap F_{A_2} = \emptyset$ and $F_{A_1} \cap cl(F_{A_2}) = \emptyset$. As $sg^{**}cl(F_{A_1}) \subseteq cl(F_{A_1})$. $\Rightarrow sg^{**}cl(F_{A_1}) \cap F_{A_2} \subseteq cl(F_{A_1}) \cap F_{A_2} = \emptyset$. Similarly, $F_{A_1} \cap sg^{**}cl(F_{A_2}) \subseteq F_{A_1} \cap cl(F_{A_2}) = \emptyset$.

Thus F_{A_1} and F_{A_2} are soft g^{**} -separated sets.

The converse of the above theorem need not be true as seen from the following example.

EXAMPLE: 3.6

Let $X = \{a, b, c\}$, $E = \{e_1, e_2, e_3\}$

$A = \{e_1, e_2\} \subseteq E$

$F_A = \{(e_1, \{a\}), (e_2, \{b, c\})\}$





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$$F_{A_1} = \{(e_1, \{a\})\}$$

$$F_{A_2} = \{(e_1, \{a\}), (e_2, \{b\})\}$$

$$F_{A_3} = \{(e_1, \{b\}), (e_2, \{c\})\}$$

$$F_{A_4} = F_A$$

$$F_{A_5} = \{(e_1, \{b\})\}$$

$$F_{A_6} = \{(e_2, \{c\})\}$$

$$F_{A_7} = \{(e_2, \{b, c\})\}$$

$$F_{A_8} = F_\phi$$

soft open sets of $\tilde{\tau} = \{F_A, F_\phi, F_{A_7}, F_{A_2}\}$

soft closed sets = $\{F_\phi, F_A, F_{A_3}, F_{A_1}\}$

soft g^{**} -closed sets are $= \{F_A, F_\phi, F_{A_1}, F_{A_3}, F_{A_6}\}$

soft g^{**} -open sets are $= \{F_A, F_\phi, F_{A_2}, F_{A_5}, F_{A_7}\}$

Consider two soft Sets F_{A_1} and F_{A_6}

$$sg^{**}cl(F_{A_1}) = F_{A_1} \text{ and } sg^{**}cl(F_{A_6}) = F_{A_6}$$

Here F_{A_1} and F_{A_6} are soft g^{**} -separated sets but not soft separated sets.

$$\text{Since, } sg^{**}cl(F_{A_1}) \cap F_{A_6} = F_{A_1} \cap F_{A_6} = \emptyset$$

$$F_{A_1} \cap sg^{**}cl(F_{A_6}) = F_{A_1} \cap F_{A_6} = \emptyset$$

$$\Rightarrow F_{A_1} \cap cl(F_{A_6}) \neq \emptyset$$

THEOREM: 3.7

If F_{A_1} and F_{A_2} are soft g^{**} -separated Sets then $F_{A_1} \cup F_{A_2}$ is soft g^{**} -closed then F_{A_1} and F_{A_2} are Soft g^{**} -closed sets.

Proof:

Since F_{A_1} and F_{A_2} are soft g^{**} -separated Sets, then

$$sg^{**}cl(F_{A_1}) \cap F_{A_2} = \emptyset \text{ and}$$

$$F_{A_1} \cap sg^{**}cl(F_{A_2}) = \emptyset.$$

If $F_{A_1} \cup F_{A_2}$ is soft g^{**} -closed set, then

$$sg^{**}\{cl(F_{A_1}) \cup (F_{A_2})\} = F_{A_1} \cup F_{A_2}$$

$$\Rightarrow sg^{**}cl(F_{A_1}) \cup sg^{**}(F_{A_2}) = F_{A_1} \cup F_{A_2}$$

$$\text{Now } sg^{**}cl(F_{A_1}) \subseteq sg^{**}cl(F_{A_1}) \cup sg^{**}cl(F_{A_2})$$

$$= F_{A_1} \cup F_{A_2}$$

$$\Rightarrow \{sg^{**}cl(F_{A_1}) \cap ((F_{A_1}) \cup (F_{A_2}))\} = sg^{**}cl(F_{A_1})$$

$$\Rightarrow \{sg^{**}cl(F_{A_1}) \cap (F_{A_1})\} \cup \{sg^{**}cl(F_{A_1}) \cap (F_{A_2})\} = sg^{**}cl(F_{A_1})$$

$$\Rightarrow F_{A_1} \cup \emptyset = sg^{**}cl(F_{A_1}). \text{ Since } F_{A_1} \subseteq sg^{**}cl(F_{A_1})$$

$$\Rightarrow F_{A_1} = sg^{**}cl(F_{A_1}). \text{ Therefore } F_{A_1} \text{ is soft } g^{**}\text{-closed.}$$

$$\text{Similarly, } sg^{**}cl(F_{A_2}) \subseteq sg^{**}cl(F_{A_1}) \cup sg^{**}cl(F_{A_2})$$

$$= F_{A_1} \cup F_{A_2}$$

$$\Rightarrow \{sg^{**}cl(F_{A_2}) \cap ((F_{A_1}) \cup (F_{A_2}))\} = sg^{**}cl(F_{A_2})$$

$$\Rightarrow \{sg^{**}cl(F_{A_2}) \cap (F_{A_1})\} \cup \{sg^{**}cl(F_{A_2}) \cap (F_{A_2})\} = sg^{**}cl(F_{A_2})$$

$$\Rightarrow \emptyset \cup F_{A_2} = sg^{**}cl(F_{A_2}). \text{ Since } F_{A_2} \subseteq sg^{**}cl(F_{A_2})$$

$$\Rightarrow F_{A_2} = sg^{**}cl(F_{A_2}). \text{ Therefore } F_{A_2} \text{ is soft } g^{**}\text{-closed.}$$

THEOREM: 3.8

If G_{A_1} and G_{A_2} are soft g^{**} -separated sets and $F_{A_1} \subseteq G_{A_1}$ and $F_{A_2} \subseteq G_{A_2}$ then F_{A_1} and F_{A_2} are soft g^{**} -separated Sets.





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Proof:

Let G_{A_1} and G_{A_2} are soft g **-separated sets.

$$\Rightarrow sg ** cl(G_{A_1}) \cap G_{A_2} = \emptyset \text{ and } G_{A_1} \cap sg ** cl(G_{A_2}) = \emptyset$$

As $F_{A_1} \subseteq G_{A_1}$ and $F_{A_2} \subseteq G_{A_2}$

$$sg ** cl\{F_{A_1} \subseteq G_{A_1}\} \text{ and } sg ** cl\{F_{A_2} \subseteq G_{A_2}\}$$

$$\Rightarrow sg ** cl(F_{A_1}) \subseteq sg ** cl(G_{A_1})$$

$$sg ** cl(F_{A_1}) \cap F_{A_2} \subseteq sg ** cl(G_{A_1}) \cap F_{A_2} \\ \subseteq sg ** cl(G_{A_1}) \cap G_{A_2}$$

$$sg ** cl(F_{A_1}) \cap F_{A_2} \subseteq \emptyset$$

$$sg ** cl(F_{A_1}) \cap F_{A_2} \subseteq \emptyset \rightarrow (1)$$

Similarly, $sg ** cl(F_{A_2}) \subseteq sg ** cl(G_{A_2})$

$$sg ** cl(F_{A_2}) \cap F_{A_1} \subseteq sg ** cl(G_{A_2}) \cap F_{A_1} \\ \subseteq sg ** cl(G_{A_2}) \cap G_{A_1} \subseteq \emptyset$$

$$sg ** cl(F_{A_2}) \cap F_{A_1} = \emptyset. \rightarrow (2)$$

From (1) and (2), F_{A_1} and F_{A_2} are soft g **-separated Sets.

THEOREM: 3.9

If F_{A_1} and F_{A_2} are soft g **-open sets, then $F_{A_1} \cap F_{A_2}^c$ and $F_{A_1}^c \cap F_{A_2}$ are soft g **-separated sets.

Proof:

Let F_{A_1} and F_{A_2} are soft g **-open sets, then $F_{A_1}^c$ and $F_{A_2}^c$ are soft g **-closed sets. By the above theorem (3.8) we have $F_{A_1} \cap F_{A_1}^c$ and $F_{A_2} \cap F_{A_2}^c$ are soft g **-separated sets.

THEOREM: 3.10

If F_{A_1} and F_{A_2} are soft g **-separated sets of soft topological space $(F_A, \tilde{\tau})$ such that $(F_A, \tilde{\tau}) = F_{A_1} \cup F_{A_2}$, then $F_{A_1}^c$ and $F_{A_2}^c$ are also soft g **-separated sets.

Proof:

Let F_{A_1} and F_{A_2} are soft g **-separated sets.

$$\Rightarrow sg ** cl(F_{A_1}) \cap F_{A_2} = \emptyset \text{ and }$$

$$F_{A_1} \cap sg ** cl(F_{A_2}) = \emptyset$$

As $F_A = F_{A_1} \cup F_{A_2}$ and $F_{A_1} \cap F_{A_2} = \emptyset$

We have $F_{A_1} = F_{A_2}^c$ and $F_{A_2} = F_{A_1}^c$

Now, $sg ** cl(F_{A_1}^c) \cap F_{A_2}^c = sg ** cl(F_{A_2}) \cap F_{A_1} = \emptyset$ and

$$sg ** cl(F_{A_2}^c) \cap F_{A_1}^c = sg ** cl(F_{A_1}) \cap F_{A_2} = \emptyset$$

$\Rightarrow F_{A_1}^c$ and $F_{A_2}^c$ are soft g **-separated Sets.

THEOREM: 3.11

If two soft sets F_{A_1} and F_{A_2} are soft g **-separated sets iff there exist two soft g **-open sets G_{A_1} and G_{A_2} such that $F_{A_1} \subseteq G_{A_1}$ and $F_{A_2} \subseteq G_{A_2}$ and $F_{A_1} \cap G_{A_2} = \emptyset$ and $F_{A_2} \cap G_{A_1} = \emptyset$

Proof:

Let F_{A_1} and F_{A_2} are soft g **-separated sets. Then

$$sg ** cl(F_{A_1}) \cap F_{A_2} = \emptyset \text{ and } F_{A_1} \cap sg ** cl(F_{A_2}) = \emptyset$$

$$\text{Let } G_{A_2} = sg ** cl(F_{A_1}^c) \text{ and } G_{A_1} = sg ** cl(F_{A_2}^c)$$

Then G_{A_1} and G_{A_2} are soft g **-open sets such that

$$F_{A_1} \subseteq G_{A_1}, F_{A_2} \subseteq G_{A_2} \text{ and }$$

$$F_{A_1} \cap G_{A_2} = F_{A_1} \cap sg ** cl(F_{A_1}^c)$$





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$$= F_{A_1} \subseteq F_{A_1}^c$$

$$F_{A_1} \cap G_{A_2} = \emptyset$$

Similarly, we have $F_{A_2} \cap G_{A_1} = \emptyset$

Conversely,

Let G_{A_1} and G_{A_2} be two soft g ** -open sets such that $F_{A_1} \subseteq G_{A_1}$ and $F_{A_2} \subseteq G_{A_2}$,

$$F_{A_1} \cap G_{A_2} = \emptyset \text{ and } F_{A_2} \cap G_{A_1} = \emptyset.$$

Since $G_{A_1}^c$ and $G_{A_2}^c$ are soft g ** -closed sets.

$$\Rightarrow sg ** cl(G_{A_1}^c) = G_{A_1} \text{ and}$$

$$sg ** cl(G_{A_2}^c) = G_{A_2}.$$

Now $F_{A_1} \subseteq G_{A_2}^c$

$$\Rightarrow sg ** cl(F_{A_1}) \subseteq sg ** cl(G_{A_2}^c)$$

$$\Rightarrow sg ** cl(F_{A_1}) = G_{A_2}^c$$

$$\subseteq F_{A_2}^c$$

$$\Rightarrow sg ** cl(F_{A_1}) \subseteq F_{A_2}^c$$

$$\Rightarrow sg ** cl(F_{A_1}) \cap F_{A_2} = \emptyset \quad \rightarrow (1)$$

and $F_{A_2} \subseteq G_{A_1}^c$

$$\Rightarrow sg ** cl(F_{A_2}) \subseteq sg ** cl(G_{A_1}^c)$$

$$= G_{A_1}^c \subseteq F_{A_1}^c$$

$$\Rightarrow sg ** cl(F_{A_2}) \subseteq F_{A_1}^c$$

$$\Rightarrow sg ** cl(F_{A_2}) \cap F_{A_1} = \emptyset \quad \rightarrow (2)$$

From (1) and (2), F_{A_1} and F_{A_2} are Soft g ** - Separated Sets.

SOFT g ** - CONNECTED AND SOFT g ** - DISCONNECTED SPACE

DEFINITION: 4.1

A soft topological space $(F_A, \tilde{\tau})$ is soft g ** -disconnected space if we can write F_A as union of two non-null Soft g ** -separated sets.

(ie) $(F_A, \tilde{\tau}) = F_{A_1} \cup F_{A_2}$ where $F_{A_1} \neq \emptyset$, $F_{A_2} \neq \emptyset$ and $sg ** cl(F_{A_1}) \cap F_{A_2} = \emptyset$ and $F_{A_1} \cap sg ** cl(F_{A_2}) = \emptyset$. Otherwise the soft topological space. $(F_A, \tilde{\tau})$ is called soft g ** - connected space.

EXAMPLE: 4.2

In the above example 3.2, We take F_{A_3} and F_{A_6} be the two soft sets over $(F_A, \tilde{\tau})$ then $F_A = F_{A_3} \cup F_{A_6}$, $F_{A_3} \neq \emptyset$ and $F_{A_6} \neq \emptyset$.

$$sg ** cl(F_{A_3}) = F_{A_3},$$

$$sg ** cl(F_{A_6}) = F_{A_4}.$$

$$sg ** cl(F_{A_3}) \cap F_{A_6} = F_{A_3} \cap F_{A_6} = \emptyset.$$

$$F_{A_3} \cap sg ** cl(F_{A_6}) = F_{A_3} \cap F_{A_4} = \emptyset.$$

$\therefore (F_A, \tilde{\tau})$ is soft g ** -disconnected space.

EXAMPLE: 4.3

Let $X = \{a, b, c, d\}$, $E = \{e_1, e_2\}$

$$A = \{e_1, e_2\} \subseteq E$$

$$F_A = \{(e_1, \{a, b\}), (e_2, \{c, d\})\}$$

$$F_{A_1} = \{(e_1, \{a\})\}$$

$$F_{A_2} = \{(e_1, \{b\})\}$$

$$F_{A_3} = \{(e_1, \{a, b\})\}$$

$$F_{A_4} = \{(e_2, \{c\})\}$$

$$F_{A_5} = \{(e_2, \{d\})\}$$

$$F_{A_6} = \{(e_2, \{c, d\})\}$$





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$$F_{A_7} = \{(e_1, \{a\}), (e_2, \{c\})\}$$

$$F_{A_8} = \{(e_1, \{b\}), (e_2, \{d\})\}$$

$$F_{A_9} = \{(e_1, \{a, b\}), (e_2, \{c\})\}$$

$$F_{A_{10}} = \{(e_1, \{a, b\}), (e_2, \{d\})\}$$

$$F_{A_{11}} = \{(e_1, \{a\}), (e_2, \{c, d\})\}$$

$$F_{A_{12}} = \{(e_1, \{b\}), (e_2, \{c, d\})\}$$

$$F_{A_{13}} = \{(e_1, \{a\}), (e_2, \{d\})\}$$

$$F_{A_{14}} = \{(e_1, \{b\}), (e_2, \{c\})\}$$

$$F_{A_{15}} = F_A$$

$$F_{A_{16}} = F_\emptyset$$

soft open sets of $\tilde{\tau} = \{F_A, F_\emptyset, F_{A_3}, F_{A_{11}}, F_{A_7}, F_{A_9}, F_{A_{10}}\}$

soft closed sets = $\{F_\emptyset, F_A, F_{A_2}, F_{A_4}, F_{A_5}, F_{A_8}, F_{A_6}\}$

soft g^{**} -closed sets are = $\{F_A, F_\emptyset, F_{A_2}, F_{A_4}, F_{A_5}, F_{A_6}, F_{A_8}, F_{A_{12}}\}$

soft g^{**} -open sets are = $\{F_A, F_\emptyset, F_{A_{11}}, F_{A_{10}}, F_{A_9}, F_{A_3}, F_{A_7}, F_{A_1}\}$

Now let F_{A_7} and F_{A_9} be the two soft sets over $(F_A, \tilde{\tau})$, then $F_A = F_{A_7} \cup F_{A_{10}}$, where $F_{A_7} \neq \emptyset$ and $F_{A_{10}} \neq \emptyset$. sg^{**}

$$cl(F_{A_7}) = F_A \text{ and } sg^{**} cl(F_{A_{10}}) = F_A$$

$$\Rightarrow sg^{**} cl(F_{A_7}) \cap F_{A_{10}} \neq \emptyset. \text{ Similarly, } (F_{A_7}) \cap sg^{**} F_{A_{10}} \neq \emptyset.$$

Thus we cannot able to write F_A as union of two non null soft g^{**} -separated sets. Therefore $(F_A, \tilde{\tau})$ is soft g^{**} -connected space.

THEOREM: 4.4

Every soft disconnected space is a soft g^{**} - disconnected space.

Proof

Let $(F_A, \tilde{\tau})$ be a soft disconnected space. Now by definition,

$F_A = F_{A_1} \cup F_{A_2}$, where $F_{A_1} \neq \emptyset$ and $F_{A_2} \neq \emptyset$ such that F_{A_1} and F_{A_2} are soft seperable sets. By theorem 3.5 we have F_{A_1} and F_{A_2} are soft g^{**} -seperated sets [(ie) Any two soft seperated sets are Soft g^{**} -seperated sets]

$$\Rightarrow F_A = F_{A_1} \cup F_{A_2}. \text{ Thus } (F_A, \tilde{\tau}) \text{ is soft } g^{**}\text{-disconnected space.}$$

The converse of the above theorem need not be true as seen from the following example.

EXAMPLE: 4.5

Let us take the example 4.2 here F_{A_3} and F_{A_6} are soft g^{**} -seperated sets over $(F_A, \tilde{\tau})$ but they are not soft seperated sets. Since

$$cl(F_{A_3}) = F_A \text{ and } cl(F_{A_6}) = F_{A_4}$$

$$\Rightarrow F_A = F_{A_3} \cup F_{A_6}, \text{ where } F_{A_3} \neq \emptyset \text{ and } F_{A_6} \neq \emptyset.$$

$$cl(F_{A_3}) \cap F_{A_6} = F_A \cap F_{A_6}$$

$$\Rightarrow cl(F_{A_3}) \cap F_{A_6} \neq \emptyset \text{ and}$$

$$F_{A_3} \cap cl(F_{A_6}) = F_{A_3} \cup F_{A_4}$$

$$\Rightarrow F_{A_3} \cap cl(F_{A_6}) \neq \emptyset$$

$$\therefore (F_A, \tilde{\tau}) \text{ is not a soft disconnected Space.}$$

THEOREM: 4.6

Let $(F_A, \tilde{\tau})$ be a soft g^{**} -disconnected space in a soft topological space iff there exists a non-null proper soft subset of F_A which is both soft g^{**} -open and Soft g^{**} -closed set.

Proof:

Let $(F_A, \tilde{\tau})$ be a soft g^{**} - disconnected space. By definition, there exists non-null soft sets F_{A_1} and F_{A_2} , where $F_A = F_{A_1} \cup F_{A_2}$ such that $sg^{**} cl(F_{A_1}) \cap F_{A_2} = \emptyset$ and $F_{A_1} \cap sg^{**} cl(F_{A_2}) = \emptyset$.

$$\Rightarrow F_{A_1} \cap F_{A_2} = \emptyset \text{ and } F_A = F_{A_1} \cup F_{A_2}$$





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Now, $sg ** cl(F_{A_1}) \cap F_{A_2} = \emptyset$ and $F_{A_1} \cap sg ** cl(F_{A_2}) = \emptyset$.

$$\begin{aligned} \Rightarrow sg ** cl(F_{A_1}) &\subseteq F_{A_2}^c = F_{A_1} \\ \Rightarrow sg ** cl(F_{A_1}) &\subseteq F_{A_1} \text{ and} \\ sg ** cl(F_{A_2}) &\subseteq F_{A_1}^c = F_{A_2} \\ \Rightarrow sg ** cl(F_{A_2}) &\subseteq F_{A_2} \end{aligned}$$

This implies that,

$$\begin{aligned} sg ** cl(F_{A_1}) &\subseteq F_{A_1} \text{ and} \\ sg ** cl(F_{A_2}) &\subseteq F_{A_2} \end{aligned} \rightarrow (1)$$

But, we know that,

$$\begin{aligned} F_{A_1} &\subseteq sg ** cl(F_{A_1}) \text{ and} \\ F_{A_2} &\subseteq sg ** cl(F_{A_2}) \end{aligned} \rightarrow (2)$$

From (1) and (2), we have

$$F_{A_1} = sg ** cl(F_{A_1}) \text{ and } F_{A_2} = sg ** cl(F_{A_2}).$$

Therefore F_{A_1} and F_{A_2} are soft $g **$ -closed sets and hence $F_{A_1}^c = F_{A_2}$ and $F_{A_2}^c = F_{A_1}$ are soft $g **$ -open sets. Thus we have non-null proper soft subset of F_A which is soft $g **$ -open as well as soft $g **$ -closed sets.

Conversely, Let F_{A_1} be the non-null proper soft subset of F_A which is both soft $g **$ -open as well as soft $g **$ -closed.

Then $F_{A_1}^c = F_{A_2}$ is non-null proper subset of F_A which is also soft $g **$ -open as well as soft $g **$ -closed. Also

$F_{A_1} \cap F_{A_2} = \emptyset$. Now by theorem 3.3, we have F_{A_1} and F_{A_2} are soft $g **$ -separated sets such that $F_A = F_{A_1} \cup F_{A_2}$. $\Rightarrow (F_A, \tau)$ is soft $g **$ -disconnected space.

THEOREM: 4.7

Let (F_A, τ) be a soft $g **$ -connected space in a soft topological space iff F_\emptyset and F_A are the only soft $g **$ -open and soft $g **$ -closed sets.

Proof:

Let (F_A, τ) be a soft $g **$ -connected space.

Suppose that $F_{A_1} \neq F_A$ be a non-null soft set which is both soft $g **$ -open and soft $g **$ -closed.

If $F_{A_2} = F_{A_1}^c$ then F_{A_2} is also both soft $g **$ -open and soft $g **$ -closed.

Since $F_{A_1} \cap F_{A_2} = \emptyset$

$$\begin{aligned} sg ** cl(F_{A_1}) &\subseteq F_{A_1} \text{ and} \\ sg ** cl(F_{A_2}) &\subseteq F_{A_2} \end{aligned}$$

This implies that,

$$\begin{aligned} sg ** cl(F_{A_1}) \cap F_{A_2} &= \emptyset \text{ and} \\ F_{A_1} \cap sg ** cl(F_{A_2}) &= \emptyset. \\ \Rightarrow (F_A, \tau) &\text{ is a soft } g **\text{-disconnected space.} \end{aligned}$$

Which is a Contradiction.

Thus F_\emptyset and F_A are the only soft $g **$ -open and soft $g **$ -closed sets.

Conversely,

Suppose F_\emptyset and F_A are the only soft sets which is both soft $g **$ -open and soft $g **$ -closed sets.

Claim : (F_A, τ) is a soft $g **$ -connected space.

Suppose that (F_A, τ) is not a soft $g **$ -connected space.

(ie) (F_A, τ) is a soft $g **$ -disconnected space.

Then, $F_A = F_{A_1} \cup F_{A_2}$ where $F_{A_1} \neq \emptyset$, $F_{A_2} \neq \emptyset$ such that $sg ** cl(F_{A_1}) \cap F_{A_2} = \emptyset$

and $F_{A_1} \cap sg ** cl(F_{A_2}) = \emptyset$.

$$\begin{aligned} \Rightarrow F_{A_1} \cap F_{A_2} &= \emptyset \\ \Rightarrow F_{A_1} &= F_{A_2}^c \text{ and } F_{A_2} = F_{A_1}^c \end{aligned}$$

As we know that

$$F_{A_1} \subseteq sg ** cl(F_{A_1}) \rightarrow (*)$$





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But, $sg ** cl(F_{A_1}) \cap F_{A_2} = \emptyset$
 $\Rightarrow sg ** cl(F_{A_1}) = F_{A_2}^c = F_{A_1} \rightarrow (**)$
 From (*) and (**), $F_{A_1} = sg ** cl(F_{A_1})$

Thus F_{A_1} is soft $g **$ -closed set.

Similarly, $F_{A_2} = sg ** cl(F_{A_2})$

Thus F_{A_2} is soft $g **$ -closed set.

$\Rightarrow F_{A_1}^c = F_{A_2}$ and $F_{A_2}^c = F_{A_1}$ are soft $g **$ -open sets.

Thus we have a non-null proper soft set which is both soft $g **$ -open and soft $g **$ -closed, Which is a contradiction

Thus $(F_A, \tilde{\tau})$ is a soft $g **$ -connected space.

THEOREM: 4.8

If $(F_A, \tilde{\tau})$ is a soft $g **$ -connected space, then it is soft connected space.

Proof:

Let $(F_A, \tilde{\tau})$ is a soft $g **$ -connected space.

Suppose that $(F_A, \tilde{\tau})$ is a soft disconnected space.

By definition, there exists two non-null soft sets F_{A_1} and F_{A_2}

Given that $F_A = F_{A_1} \cup F_{A_2}$ and $cl(F_{A_1}) \cap F_{A_2} = \emptyset$ and $F_{A_1} \subseteq cl(F_{A_2}) = \emptyset$.

Since, $sg ** cl(F_{A_1}) \subseteq cl(F_{A_1})$

$\therefore sg ** cl(F_{A_1}) \cap F_{A_2} \subseteq cl(F_{A_1}) \cap F_{A_2}$
 $= \emptyset$.

$\Rightarrow sg ** cl(F_{A_1}) \cap F_{A_2} = \emptyset$.

Similarly,

$sg ** cl(F_{A_2}) \subseteq cl(F_{A_2})$
 $\therefore sg ** cl(F_{A_2}) \cap F_{A_1} \subseteq cl(F_{A_2}) \cap F_{A_1}$
 $= \emptyset$.

$\Rightarrow sg ** cl(F_{A_2}) \cap F_{A_1} = \emptyset$.

$\Rightarrow F_A$ is the union of the soft $g **$ -separated sets

Which is a contradiction to the fact.

$\therefore (F_A, \tilde{\tau})$ is a soft connected space.

CONCLUSION

In this paper, we have introduced soft $g **$ -separated sets, soft $g **$ -connected space and soft $g **$ -disconnected space and also investigated some of their properties. In the extension of this work we will introduce Soft $g **$ -Separation Axioms, Soft $g **$ -Compactness etc. Also in future using this soft set, we try to find some of the real applications like Image processing, Data mining etc...

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MHD Casson Fluid Flow of Heat and Mass Transfer through A Vertical Porous Plate with Presence of an Aligned Angle and the Soret Effect

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ABSTRACT

This research aims to explore the alignment angle and soret influence on the MHD of heat and mass transfer in a porous infinite vertical plate utilizing Casson fluid flow. The plate's normal and perpendicular axes, respectively, are called the X and Y axes. Several parameter values for the transmission of heat and mass are provided by the equations of velocity, temperature, and concentration. The values of velocity increase together with the values of G_m , K , S_o and however, the values of M , S_c and also decrease. As the liquid is heated, the values of Pr , F and Q decrease while the concentration, S_o value increases. After all the parameter values were presented using Mat lab plots, the values of Skin friction, the Nusselt number, and the Sherwood number were calculated numerically using the perturbation method for the equations of velocity, temperature and concentration.

Keywords: MHD, Vertical porous plate, Aligned angle, Casson fluid, Soret effect.

INTRODUCTION

The purpose of this paper is to examine the importance of fluid dynamics in a wide range of fields, including physics, chemistry, dietetics, architecture, medicine (blood flow), environment, and engineering, among others. Numerous fluid dynamics researchers have emerged in recent years. The Casson liquid is mostly used as a model for



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non-Newtonian fluid behavior in scientific and industrial research. A visco elastic fluid and a Maxwell fluid are two more names for a Casson fluid. There is a yield stress in Casson fluid. A Casson fluid is a thin shear fluid. A Casson contains infinite viscosity at zero shear rates. This could be seen as a sign that the fluid's yield stress is much higher than its shear stress. The fluid will move if its pressure is higher than its shear stress. Common examples of Casson fluid are soup, tomato sauce, jelly, honey, concentrated fruit juices, etc. It is also the most appropriate rheological model for blood and chocolate. Processing of polymers and Casson yield are also essential in industry and biomechanics. Sarojamma et al. [1] analyzed in a vertical tunnel with a stretch wall for normal tissue temperature, surrounding tissue is simultaneously exchanged with cancer tissue and Casson fluid flow with MHD is active. Ananda Reddy and Janardhan [2] defined radiation from chemical reactions has been studied in relation to the sores and Dufour effects on a vertical plate MHD Casson fluid flow with constant heat velocity concentration. Suresh et al. [3] considered the influence of magnetohydrodynamics and force buoyancy on convective mass and heat transfer flow in vertical porous plates can be seen in thermal radiation and chemical reaction processes. Ramanuja and Nagaradhika [4] have examined a vertical permeable MHD Casson fluid flow was spilled onto the surface and deflected by a synthetic reaction. Sehra et al. [5] have discussed reactions effects on the flow of a typical MHD Casson fluid with porosity and radiation. Preeti Gupta and Shalinijain [6] have been introduced the heat transmission of a vertically sheared, unstable inclined MHD Casson fluid flow through porous media is investigated using numerical analysis. Maleque [7] have depicted the flow of a non-Newtonian Casson fluid on a spinning disc is described by unsteady MHD with a porous uniform electric field. LipikaPanigrahi et al. [8]

Reported the MHD Casson Nano fluid moves through a porous medium with chemical reaction and Newtonian heating before passing through the stretched sheet. Das et al. [9] focused the double diffusive Casson fluid travels through a porous medium as the unstable MHD passes with mass transfer and chemical reaction on a heated flat plate. SunitaChoudhary and Mamta Goyal [10] has been studied through time-dependent suction and heat, the unsteady MHD Casson fluid produces a porous medium that passes through the liquid. Afikuzzaman and Mahmud Alam [11] initiated in MHD Casson fluid flow, uniform magnetic field is applied perpendicularly to parallel plates with mass transfer and free convection. MusharafaSaleem et al. [12] explored two parameters lie in the scaling strategy for an unsteady MHD Casson fluid flow through a porous solid plate's stagnation point at constant temperature. ManjulaKatageri [13] defined laminar flow of a magnetic field boundary over a Casson fluid with an elastic sheet. FarukAbdullahi et al. [14] presented effects of free convection from MHD transient heat transfer over mass transfer on Casson fluid flow across an infinite vertical plate. Pushpalatha et al. [15] obtained convective boundary conditions with unstable MHD Casson fluid flow for heat and mass transfer. Rama Mohan and Maheshbabu [16] proposed a Casson fluid with an uneven heat transfer flow can be pumped through porous media using an aligned magnetic fluid. Ramana Reddy et al. [17] have developed the effect of the aligned magnetic field may be seen when a vertical plate is exactly positioned in the Centre and oscillates in a Casson fluid flow past. ChennaSumalatha et al. [18] presented on a heat layer with a stretched sheet in a medium, the effects of a magnetic field aligned with it and thermal radiation are investigated. Mahesh Reddy [19] are contemplated by removing an aligned thickness from the fluid flow's surface, the aligned magnetic field defects can be identified.

Vijayaragavan et al. [20] has been studied Dufour investigates the effects of mass and heat transfer on an inclined porous plate as well as the effects of chemical reaction on the Casson flow past the MHD. Renu Devi et al. [21] showed to investigate the effects of the heat source and the aligned magnetic field on the Casson fluid flow, the inclined external velocity is altered using a stretched sheet. Nawal et al. [22] Obtained crossing a viscous stretching/shrinking surface in an unstable cutting MHD flow with heat transfer and the presence of several solutions in a Nano fluid. . Ramaiah and Rama Krishna Prasad [23] presented the use of thermal processes and an aligned magnetic field in free convective flow through an incline surface in unstable MHD. Pavan Kumar [24] are investigated calculation of thermal diffusion and the effects of an inclined magnetic field during an MHD free convection flow past an inclined plate. ObulesuMopuri et al. [25] extended a few MHD heat and mass transfer parameters in the presence of a porous plate and a continuous convective fluid flow. Muthuracku Alias Prema and Muthucumaraswamy [26] have examined Hall Effect and flow during rotation in the presence of exponentially accelerated vertical plate heat and mass transfer in the past. Srikanth and Palani [27] obtained in a vertical plate with





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double diffusion, chemical reactions take place in natural convection flow. Mehran Ahmadi et al. [28] showed natural convection vertical parallel plates are used to calculate the solution in an integrated manner. Zigta [29] initiated MHD blood flow results from a chemical reaction caused by stretching and plays a part in thermal radiation. Shiva Jagadeesh et al. [30] have provided effect of nonlinear thermal radiation on temperature, slip state, and surface stretching/shrinking during 3D nanofluid flow. Prameela [31] investigated the result of thermal radiation on MHD fluid is a sphere. Sahu and Rajput [32] are contemplated thermal diffusion and chemical reaction impacts of free convection in MHD fluid flow control steady-state heat flux on the vertical surface of a porous material. Raghunandana Sai and V Ramana Murthy [33] have depicted heat radiation in the presence of an infinite MHD fluid flow while moving a vertical porous plate. Lakshmi Priya and Madhumitha [34] examined Prandtl study of mixed oscillatory unsteady MHD flow with moderate sores effects in a porous medium. Rajput and Gaurav Kumar [35] explored unsteady MHD flow over an inclined plate with varying cover temperature in the past porous medium: oscillating mass distribution and the sores effect. HidayatUllah et al. [36] presented Dufour and Soret effects of parallel concentration cylinders between ionic liquid grafts are analyzed parametrically. Shashidar Reddy and Saritha [37] defined MHD boundary layer slip flow along a flat plate with Soret and Dufour effects. In order to solve the heat transfer and radiation effect equations in steady Casson fluid flow through an infinite vertical plate embedded in a porous medium, the current thesis uses partial differential equations. The solved equations can be subjected to numerical analysis. This investigation is a follow-up to ObulusuMopuri et al. [25]. This study considers the flow of a convective fluid in the presence of MHD heat and mass transfer in a porous plate.

Mathematical formulation

Consider the flow of an incompressible electric Casson liquid through a semi-infinite vertical porous plate that is encased in a porous medium. The magnetic field strength through a plate with a transverse curve over an angle θ magnetic field is perpendicular, and the x and y axes are oriented upward and normally, respectively. As a result, the applied magnetic field is very small in comparison to the induced magnetic field. The chemical equation of state for incompressible flow of a Casson liquid can be expressed as

Fundamental equation

The equations for a viscous incompressible Casson fluid flow in the presence of a porous vertical plate magnetic field are

Continuity equation

$$\nabla \cdot \bar{q} = 0$$

Equation for momentum

$$\rho \left[(\bar{q} \cdot \nabla) \bar{q} \right] = -\nabla p + \bar{J} \times \bar{B} + \rho \bar{g} + \mu \nabla^2 \bar{q} - \left[\frac{\mu}{K^*} \right] \bar{q}$$

Ohm's law

$$\bar{J} = \sigma \left[\bar{E} + (\bar{q} \times \bar{B}) \right]$$

Magnetism's Gauss law

$$\nabla \cdot \bar{B} = 0$$

Equation for energy

$$\rho C_p \left[(\bar{q} \cdot \nabla) T^* \right] = K \nabla^2 T^* + \mu (\nabla \cdot \bar{q})^2 - \nabla q_r^* + \mu \nabla^2 \bar{q}^2 - Q^* (T^* - T_\infty^*)$$

Equation for species continuity

$$(\bar{q} \cdot \nabla) C^* = D_M \nabla^2 C^* + K^* (C_\infty^* - C^*) + \frac{D_M K_T}{T_M} \nabla^2 T^*$$

Using the fundamental equation mentioned above, a mathematical equation was examined.





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$$\frac{\partial v'}{\partial y'} = 0 \quad (1)$$

$$v' \frac{\partial u'}{\partial y'} = g \left(1 + \frac{1}{\gamma} \right) \frac{\partial^2 u'}{\partial y'^2} + g \beta_T (T' - T'_\infty) + g \beta_C (C' - C'_\infty) - \frac{\sigma B_0^2}{\rho} u' \sin^2 \delta - g \frac{u'}{K_p} \quad (2)$$

$$v' \frac{\partial T'}{\partial y'} = \frac{K}{\rho C_p} \frac{\partial^2 T'}{\partial y'^2} + \frac{g}{C_p} \left(1 + \frac{1}{\gamma} \right) \left(\frac{\partial u'}{\partial y'} \right)^2 - \frac{1}{\rho C_p} \frac{\partial q_r'}{\partial y'} + \frac{\sigma B_0^2}{\rho C_p} u'^2 - \frac{Q_1}{\rho C_p} (T' - T'_\infty) \quad (3)$$

$$v' \frac{\partial C'}{\partial y'} = D \frac{\partial^2 C'}{\partial y'^2} - K_c (C' - C'_\infty) + D_1 \frac{\partial^2 T'}{\partial y'^2} \quad (4)$$

The velocity, temperature, and concentration fields' boundaries are defined as follows:

$$\begin{aligned} u' = 0, \quad T' = T_w, \quad C' = C_w \quad \text{at } y' = 0 \\ u' \rightarrow 0, \quad T' \rightarrow T_\infty, \quad C' \rightarrow C_\infty \quad \text{at } y' \rightarrow \infty \end{aligned} \quad (5)$$

$$\text{Equation (1) is integrating we get, } v' = -v_0 (v_0 > 0) \quad (6)$$

where v_0 is constant

We take into account a mathematical model proposed by Praveen Kumar et al. [24] for an optically thin limit grey gas close to equilibrium.

$$\frac{\partial q_r'}{\partial y'} = 4I_1 (T' - T'_\infty) \quad (7)$$

where $I_1 = \int_0^\infty K_{\lambda_w} \frac{de_{b\lambda}}{dT'} d\lambda$, K_{λ_w} = Planck's function is the wall's absorption coefficient.

The similarity variable we use is defined as follows:

$$\begin{aligned} u = \frac{u'}{v_0}, \quad y = \frac{v_0 y'}{g}, \quad \theta = \frac{(T' - T'_\infty)}{(T_w - T'_\infty)}, \quad \phi = \frac{(C' - C'_\infty)}{(C_w - C'_\infty)}, \quad \text{Pr} = \frac{\mu C_p}{K}, \quad \text{Sc} = \frac{g}{D}, \quad M = \frac{\sigma B_0^2 g}{\rho v_o^2}, \\ \text{Gr} = \frac{g \beta_T (T_w - T'_\infty)}{v_o^3}, \quad \text{Gm} = \frac{g \beta_C (C_w - C'_\infty)}{v_o^3}, \quad E = \frac{v_o^2}{C_p (T_w - T'_\infty)}, \quad K = \frac{v_o^2 K_p}{g^2}, \\ K_o = \frac{g K_c}{v_o^2}, \quad F = \frac{4I_1 g^2}{K v_o^2}, \quad Q = \frac{Q_1 v^2}{K v_o^2}, \quad \text{So} = \frac{D_1 (T_w - T'_\infty)}{g (C_w - C'_\infty)} \end{aligned} \quad (8)$$

Using equation (2) to (4) are reduced to the following non-dimensional form:

$$\left(1 + \frac{1}{\gamma} \right) u'' + u' = -\text{Gr}\theta - \text{Gm}\phi + M_1 u \quad (9)$$

$$\theta'' + \text{Pr}\theta' - (F + Q)\theta = -\text{Pr} \left(1 + \frac{1}{\gamma} \right) u'^2 E - \text{Pr} M u^2 E \quad (10)$$

$$\phi'' + \text{Sc}\phi' - \text{Sc}K_o\phi = -S_o \text{Sc}\theta'' \quad (11)$$

$$\text{where } M_1 = M \sin^2 \delta + \frac{1}{K}$$

The associated boundary conditions are





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$$\begin{aligned} u &= 0, \quad \theta = 1, \quad \varphi = 1 \quad \text{at } y = 0 \\ u &\rightarrow 0, \quad \theta \rightarrow 0, \quad \varphi \rightarrow 0 \quad \text{at } y \rightarrow \infty \end{aligned} \quad (12)$$

Solution of the problem

Equations (9) to (11) are a set of connected, nonlinear partial differential equations whose exact solutions are not known but which can be reduced to a set of solvable partial differential equations. This can be accomplished analytically by expressing the distribution of velocity, temperature, and concentration as where ($E \ll 1$) is a tiny quantity.

$$\begin{aligned} u &= u_0 + Eu_1 + O(E^2) \\ \theta &= \theta_0 + E\theta_1 + O(E^2) \end{aligned} \quad (13)$$

$$\varphi = \varphi_0 + E\varphi_1 + O(E^2)$$

The following governing equation in non-dimensional form is created by putting the equation (13) into (9 to 11).

Zero order terms:

$$\left(1 + \frac{1}{\gamma}\right) u_0'' + u_0' = -Gr\theta_0 - Gm\varphi_0 + M_1 u_0 \quad (14)$$

$$\theta_0'' + Pr\theta_0' - (F + Q)\theta_0 = 0 \quad (15)$$

$$\varphi_0'' + Sc\varphi_0' - ScK_o\varphi_0 = -S_o Sc\theta_0'' \quad (16)$$

First order terms:

$$\left(1 + \frac{1}{\gamma}\right) u_1'' + u_1' = -Gr\theta_1 - Gm\varphi_1 + M_1 u_1 \quad (17)$$

$$\theta_1'' + Pr\theta_1' - (F + Q)\theta_1 = -Pr\left(1 + \frac{1}{\gamma}\right) u_0'^2 - PrMu_0^2 \quad (18)$$

$$\varphi_1'' + Sc\varphi_1' - ScK_o\varphi_1 = -S_o Sc\theta_1'' \quad (19)$$

The corresponding boundary condition are

$$\begin{aligned} u_0 &= 0, \quad u_1 = 0, \quad \theta_0 = 1, \quad \theta_1 = 0, \quad \varphi_0 = 1, \quad \varphi_1 = 0 \quad \text{at } y = 0 \\ u_0 &\rightarrow 0, \quad u_1 \rightarrow 0, \quad \theta_0 \rightarrow 1, \quad \theta_1 \rightarrow 0, \quad \varphi_0 \rightarrow 1, \quad \varphi_1 \rightarrow 0 \quad \text{at } y = \infty \end{aligned} \quad (20)$$

We obtained the solution $u_0, \theta_0, \varphi_0, u_1, \theta_1, \varphi_1$

$$\theta_o = e^{-w_1 y} \quad (21)$$

$$\varphi_o = -Z_1 e^{-w_1 y} + Z_2 e^{-w_2 y} \quad (22)$$

$$u_o = Z_3 e^{-w_1 y} - Z_4 e^{-w_2 y} + Z_5 e^{-w_3 y} \quad (23)$$

$$\theta_1 = Z_{18} e^{-2w_1 y} + Z_{19} e^{-2w_2 y} + Z_{20} e^{-2w_3 y} + Z_{21} e^{-\alpha_1 y} + Z_{22} e^{-\alpha_2 y} + Z_{23} e^{-\alpha_3 y} + Z_{24} e^{-w_1 y} \quad (24)$$

$$\varphi_1 = Z_{25} e^{-w_1 y} + Z_{26} e^{-2w_1 y} + Z_{27} e^{-2w_2 y} + Z_{28} e^{-2w_3 y} + Z_{29} e^{-\alpha_1 y} + Z_{30} e^{-\alpha_2 y} + Z_{31} e^{-\alpha_3 y} + Z_{32} e^{-w_2 y} \quad (25)$$

$$\begin{aligned} u_1 &= Z_{33} e^{-w_1 y} + Z_{34} e^{-w_2 y} + Z_{35} e^{-2w_1 y} + Z_{36} e^{-2w_2 y} + Z_{37} e^{-2w_3 y} + Z_{38} e^{-\alpha_1 y} \\ &\quad + Z_{39} e^{-\alpha_2 y} + Z_{40} e^{-\alpha_3 y} + Z_{41} e^{-w_3 y} \end{aligned} \quad (26)$$

Finally the expression for velocity, temperature, concentration are given by





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$$u = Z_3 e^{-w_1 y} - Z_4 e^{-w_2 y} + Z_5 e^{-w_3 y} + E[Z_{33} e^{-w_1 y} + Z_{34} e^{-w_2 y} + Z_{35} e^{-2w_1 y} + Z_{36} e^{-2w_2 y} + Z_{37} e^{-2w_3 y} + Z_{38} e^{-\alpha_1 y} + Z_{39} e^{-\alpha_2 y} + Z_{40} e^{-\alpha_3 y} + Z_{41} e^{-w_3 y}] \quad (27)$$

$$\theta = e^{-w_1 y} + E[Z_{18} e^{-2w_1 y} + Z_{19} e^{-2w_2 y} + Z_{20} e^{-2w_3 y} + Z_{21} e^{-\alpha_1 y} + Z_{22} e^{-\alpha_2 y} + Z_{23} e^{-\alpha_3 y} + Z_{24} e^{-w_1 y}] \quad (28)$$

$$\varphi = -Z_1 e^{-w_1 y} + Z_2 e^{-w_2 y} + E[Z_{25} e^{-w_1 y} + Z_{26} e^{-2w_1 y} + Z_{27} e^{-2w_2 y} + Z_{28} e^{-2w_3 y} + Z_{29} e^{-\alpha_1 y} + Z_{30} e^{-\alpha_2 y} + Z_{31} e^{-\alpha_3 y} + Z_{32} e^{-w_2 y}] \quad (29)$$

Skin Friction

The relation yields the skin friction in a non-dimensional form

$$\tau = \left(\frac{\partial u}{\partial y} \right)_{y=0}$$

$$\tau = [-w_1 Z_3 + w_2 Z_4 - w_3 Z_5] + E[w_1 Z_{33} - w_2 Z_{34} - 2w_1 Z_{35} - 2w_2 Z_{36} - 2w_3 Z_{37} - \alpha_1 Z_{38} - \alpha_2 Z_{39} - \alpha_3 Z_{40} - w_3 Z_{41}] \quad (30)$$

Nusselt Number

The Nusselt number in non-dimensional form can be used to calculate the rate of heat transfer co-efficient as

$$Nu = - \left(\frac{\partial \theta}{\partial y} \right)_{y=0}$$

$$Nu = w_1 + E[w_1 Z_{24} + 2w_1 Z_{18} + 2w_2 Z_{19} + 2w_3 Z_{20} + \alpha_1 Z_{21} + \alpha_2 Z_{22} + \alpha_3 Z_{23}] \quad (31)$$

Sherwood Number

The Sherwood number in non-dimensional form can be used to calculate the rate of mass transfer co-efficient as

$$Sh = - \left(\frac{\partial \varphi}{\partial y} \right)_{y=0}$$

$$Sh = [w_2 Z_2 - w_1 Z_1] + E[w_1 Z_{25} + 2w_1 Z_{26} + 2w_2 Z_{27} + 2w_3 Z_{28} + \alpha_1 Z_{29} + \alpha_2 Z_{30} + \alpha_3 Z_{31} + w_2 Z_{32}] \quad (32)$$

RESULTS AND DISCUSSION

The equations of velocity, temperature, and concentration are solved by PDE using the perturbation method, and the solved equations can be graphed using Matlab. A variety of physical parameters can be observed in fluid flow, including both incompressible mass and heat transfer in a steady MHD casson fluid in an infinite vertical porous plate embedded in a porous medium. Results demonstrate the impact of non-dimensional governing parameters such as Prandtl number (Pr), Schmidt number (Sc), Thermal Grashof number (Gr), Magnetic field parameter (M), Thermal conductivity of nano-fluid (K), Modified Grash number (Gm), Casson parameter (γ), Aligned angle (δ), Soret number (So), etc.





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The Magnetic field parameter ($M=2,3,4,4.5$), Aligned angle $\left(\delta=\frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{2}\right)$, Prandtl number ($Pr=1,2,3,7$), values are rising then its velocity depict declines, as shown in **Figures 2, 6 and 7**. The velocity depict rises in **Figures 3, 4, 5 and 8** as the Thermal conductivity of Nano fluid ($K=0.5,1,1.5,2$), Modified Grash number ($Gm=5,8,10,12$), Casson parameter ($\gamma=0.2,0.3,0.4,0.5$), Thermal Grashof number ($Gr=5,20,40,50$) values are rising. **Figures 9 to 11** shows the impacts of temperature profiles for Pr, F and Q . If there is a rising in the Prandtl number, Radiation parameter and Heat absorption parameter then temperature parameters drops as the aforementioned are also declines in vertical plates. Concentration profiles are shown as Ko, Sc and So in Figures 12 to 14. The range of So and Ko parameters expands then the concentration reduces. The concentration range expands in the similar manner as the parameter of So grows.

CONCLUSION

In this research work on Casson fluid flow in MHD with heat and mass transfer is discussed in the velocity, concentration, magnetic and chemical reaction on a porous infinite vertical plate with Soret effects at an aligned angle. The results are provided using the perturbation approach after the derived equations for Casson fluid flow are first translated into dimensionless form. Matlab is used to graphically depict the equations for the velocity, temperature and concentration in various parameter values.

The conclusions are summarized below

The fluid's velocity reduces as the value of M, Sc, δ , and Pr grows while its value increasing as the value of Gm, K, So, γ , and Gr increases. As the results, the temperature drops when heating liquid in a vertical plate as Pr, F , and Q values rise. As the values of Ko, Sc and So rising, concentration declines. Current applications of the study's findings include those in the food, medicinal, and architectural sectors for the manufacture of honey, fruit juice, and soup. These meals are grown, prepared, and shipped out to various countries. The human body undergoes a number of modifications if the food items provided in this method are consumed after the allowed period has gone. As an example, think of all the problems we deal with every day, such as nausea brought on by a virus or bacterium, headaches, loose stools, fever, diarrhoea, etc.

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Table :1 Variation of Skin friction for different physical parameters at $y=0$

M	Sc	K	Gm	So	Q	γ	δ	τ
2	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.6726





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3	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.5411
4	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.4411
4.5	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.3992
2	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.6726
2	0.30	1	5	1	1	0.5	$\frac{\pi}{3}$	1.6235
2	0.60	1	5	1	1	0.5	$\frac{\pi}{3}$	1.5343
2	0.78	1	5	1	1	0.5	$\frac{\pi}{3}$	1.5100
2	0.22	0.5	5	1	1	0.5	$\frac{\pi}{3}$	1.5050
2	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.6726
2	0.22	1.5	5	1	1	0.5	$\frac{\pi}{3}$	1.7464
2	0.22	2	5	1	1	0.5	$\frac{\pi}{3}$	1.7882
2	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.7882
2	0.22	1	8	1	1	0.5	$\frac{\pi}{3}$	2.7352
2	0.22	1	10	1	1	0.5	$\frac{\pi}{3}$	3.3665
2	0.22	1	12	1	1	0.5	$\frac{\pi}{3}$	3.9979
2	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.7882
2	0.22	1	5	2	1	0.5	$\frac{\pi}{3}$	2.0421
2	0.22	1	5	3	1	0.5	$\frac{\pi}{3}$	2.2961
2	0.22	1	5	4	1	0.5	$\frac{\pi}{3}$	2.5500





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2	0.22	1	5	1	1	0.2	$\frac{\pi}{3}$	0.9647
2	0.22	1	5	1	1	0.3	$\frac{\pi}{3}$	1.2506
2	0.22	1	5	1	1	0.4	$\frac{\pi}{3}$	1.4811
2	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.6726
2	0.22	1	5	1	1	0.5	$\frac{\pi}{6}$	1.9413
2	0.22	1	5	1	1	0.5	$\frac{\pi}{4}$	1.7882
2	0.22	1	5	1	1	0.5	$\frac{\pi}{3}$	1.6726
2	0.22	1	5	1	1	0.5	$\frac{\pi}{2}$	1.5806

Table 2. Variation of Nusselt number for different physical parameters at $y=0$.

Pr	F	Q	Nu
0.025	1	1	1.4268
0.71	1	1	1.8131
7	1	1	7.2749
7	1	1	7.2749
7	4	1	7.6533
7	6	1	7.8875
7	1	1	7.2749
7	1	3	7.5311
7	1	7	8

Table 3. Variation of Sherwood number for different physical parameters at $y=0$.

Sc	Ko	So	Sh
0.22	1	1	-0.9309
0.22	3	1	-0.5284
0.22	5	1	-0.2520
0.22	1	1	-0.9309
0.60	1	1	-2.9375
0.78	1	1	-3.9030
0.22	1	1	-0.9309
0.22	1	2	-2.4536
0.22	1	3	-3.9762



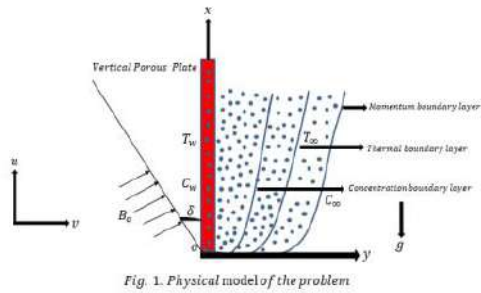
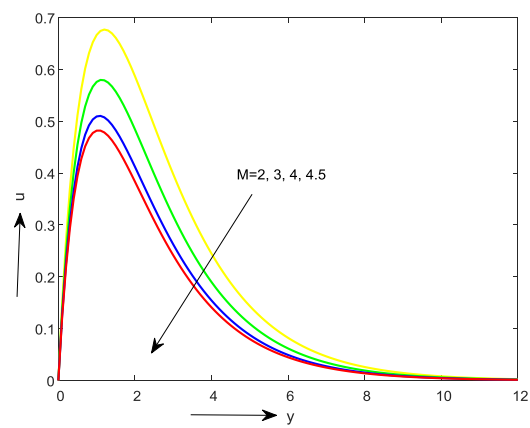
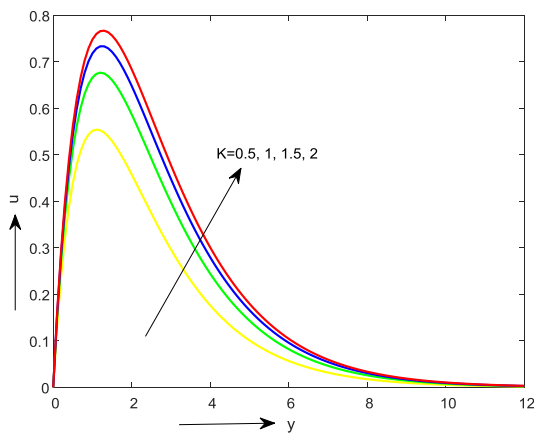
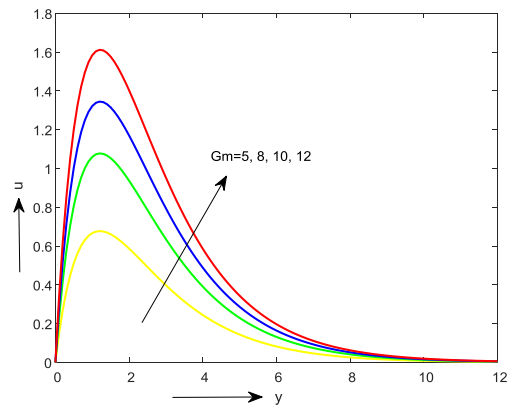


Fig. 1. Physical model of the problem

Fig. 2. Velocity profile for $Gr=5.0$ ($Sc=0.22$, $Gm=5$, $\gamma=0.5$, $\delta=\frac{\pi}{3}$, $K=1$, $Ko=1$, $Pr=7$, $F=1$, $Q=1$ and $So=1$)Fig. 3. Velocity profile for $Gr=5.0$ ($M=2$, $Gm=5$, $\gamma=0.5$, $\delta=\frac{\pi}{3}$, $Sc=0.22$, $Pr=7$, $Ko=1$, $F=1$, $Q=1$ and $So=1$)Fig. 4. Velocity profile for $Gr=5.0$ ($M=2$, $K=1$, $\gamma=0.5$, $\delta=\frac{\pi}{3}$, $Sc=0.22$, $Ko=1$, $Pr=7$, $F=1$, $Q=1$ and $So=1$)

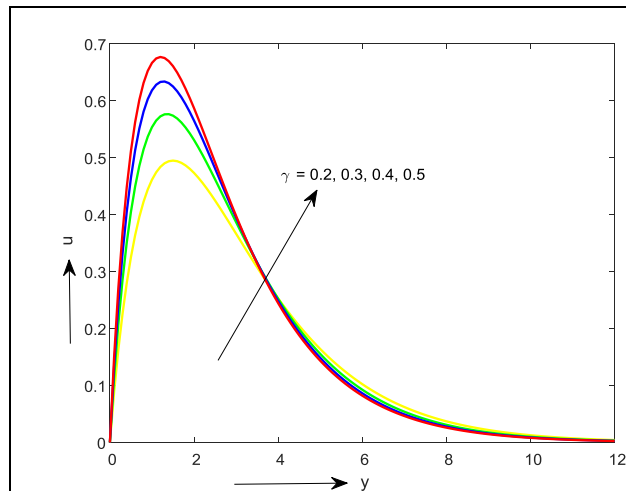


Fig. 5. Velocity profile for $Gr=5.0$ ($M=2$, $K=1$, $\delta = \frac{\pi}{3}$, $Sc=0.22$, $Ko=1$, $F=1$, $Pr=7$, $Q=1$, $So=1$ and $Gm=5$)

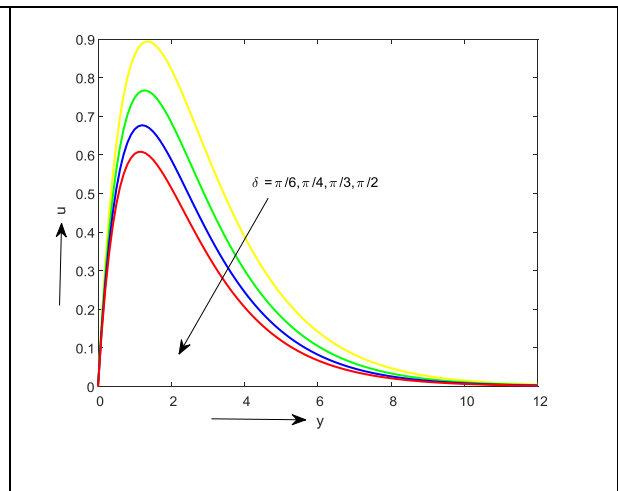


Fig. 6. Velocity profile for $Gr=5.0$ ($M=2$, $\gamma=0.5$, $K=1$, $Sc=0.22$, $Pr=7$, $Ko=1$, $F=1$, $Q=1$, $So=1$ and $Gm=5$)

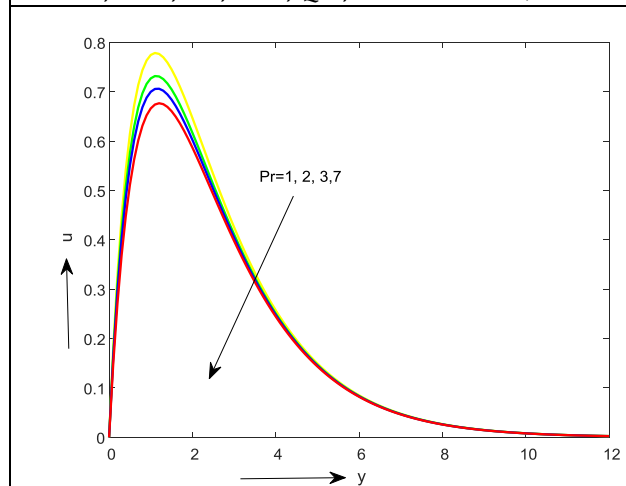


Fig. 7. Velocity profile for $Gr=5.0$ ($M=2$, $\gamma=0.5$, $K=1$, $Sc=0.22$, $\delta = \frac{\pi}{3}$, $Ko=1$, $F=1$, $Q=1$, $So=1$ and $Gm=5$)

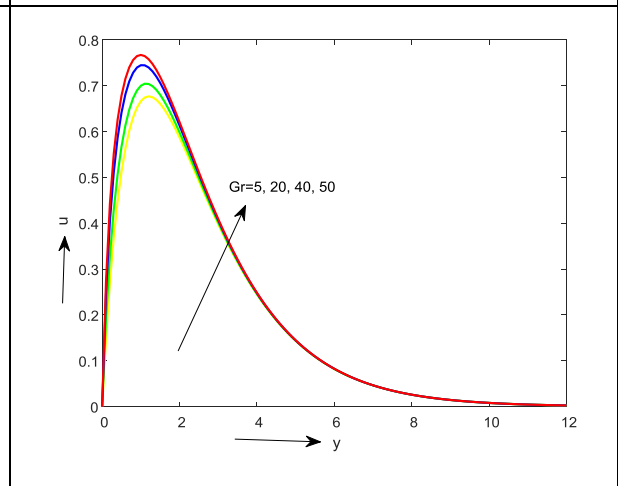


Fig. 8. Velocity profile for ($Pr=7$, $M=2$, $\gamma=0.5$, $K=1$, $Sc=0.22$, $\delta = \frac{\pi}{3}$, $Ko=1$, $F=1$, $Q=1$, $So=1$ and $Gm=5$)



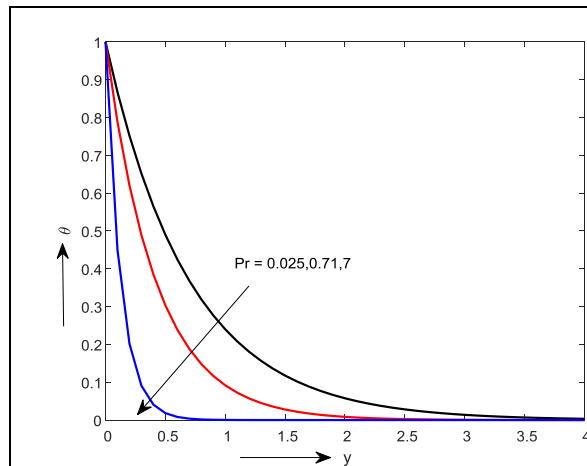


Fig. 9. Temperature profile for $Gr=5.0$ ($M=2$, $K=1$, $Sc=0.22$, $Ko=1$, $F=1$, $Q=1$, $So=1$ and $Gm=5$)

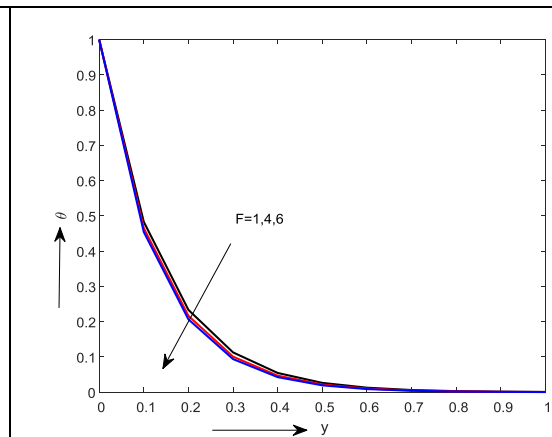


Fig. 10. Temperature profile for $Gr=5.0$ ($M=2$, $K=1$, $Pr=7$, $Sc=0.22$, $Ko=1$, $Q=1$, $So=1$ and $Gm=5$)

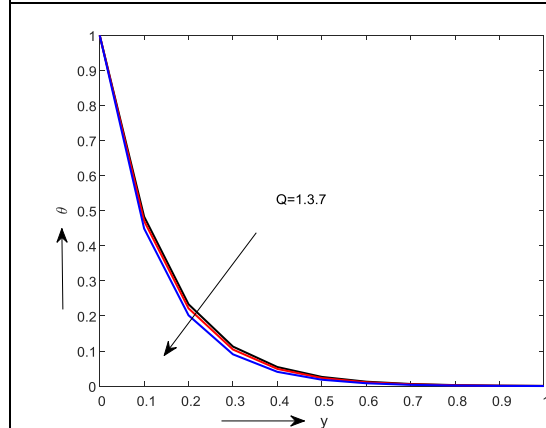


Fig. 11. Temperature profile for $Gr=5.0$ ($M=2$, $K=1$, $Pr=7$, $Sc=0.22$, $Ko=1$, $F=1$, $So=1$ and $Gm=5$)

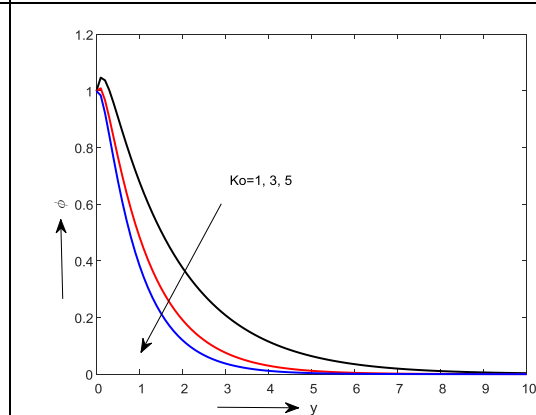


Fig. 12. Concentration profile for $Gr=5.0$ ($M=2$, $K=1$, $Sc=0.22$, $Q=1$, $Pr=7$, $F=1$, $So=1$ and $Gm=5$)

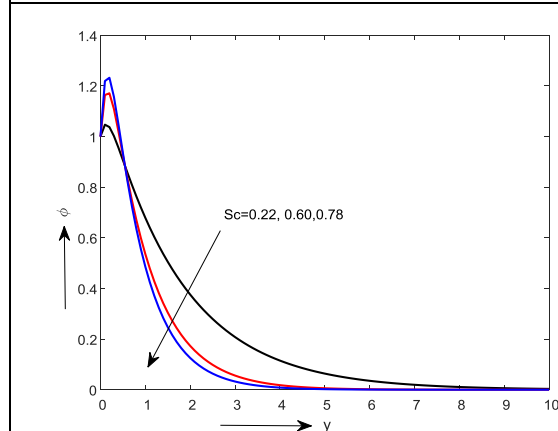


Fig. 13. Concentration profile for $Gr=5.0$ ($M=2$, $K=1$, $Ko=1$, $Q=1$, $Pr=7$, $F=1$, $So=1$ and $Gm=5$)

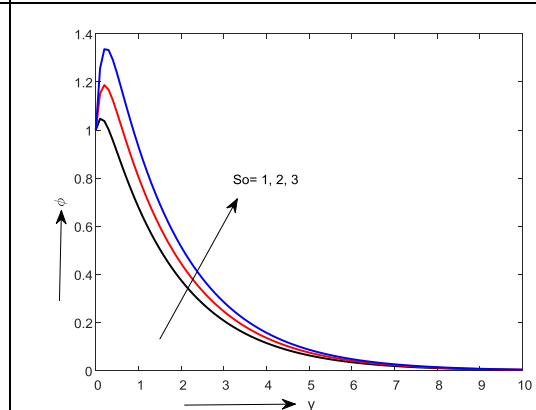


Fig. 14. Concentration profile for $Gr=5.0$ ($M=2$, $K=1$, $Ko=1$, $Q=1$, $Pr=7$, $F=1$, $Sc=0.22$ and $Gm=5$)





A New Allocation Method for Triangular Intuitionistic Fuzzy Transportation Problems for achieving Optimal Solutions

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ABSTRACT

One of the main areas of operational research is the transportation problem, which involves moving items that are initially held at various origins to their final destinations while keeping the total cost of transportation to a low. In our research work a new method for dealing with insufficient intuitionistic fuzzy transportation problems by assuming that the decision-maker is uncertain about the precise values of the transportation costs, demand, and supply of the goods. The product's supply, demand, and transportation costs are represented in the proposed method by intuitionistic fuzzy integers. To justify the potential and validity of our work, numerical computation.

Keywords: Triangular Intuitionistic Fuzzy Costs, Intuitionistic Fuzzy Transportation Problem (IFTP), Unbalanced Intuitionistic Fuzzy Transportation Problem (UIFTP), Optimal Solution.

Mathematics Subject Classification: 90C05, 90C08, 90C29.

INTRODUCTION

The transportation problem, which has rightfully garnered a lot of attention in the literature, is a significant network-structured linear programming (LP) problem that commonly arises in numerous settings. The primary concept of the challenge is to determine the lowest overall cost of transportation for a commodity to satisfy demand at destinations while utilizing resources at origins. Transportation issues can be impacted by a variety of factors, including scheduling, production, investment, plant location, inventory control, employee scheduling, and many others. Transport issues are normally resolved under the assumption that the values and costs of supply and request are





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specified precisely or in a transparent setting. But the decision-makers frequently don't have a thorough understanding of the coefficients related to the transportation issue. The fuzzy transportation problem (FTP) readily arises in these circumstances because the accompanying coefficients or components that define the problem can be described as fuzzy sets. Hitchcock was the first to formulate the fundamental transportation problem [6]. The transportation issues can be tackled using the simplex method by modelling them as a typical linear programming problem. But it was initially recognized that the transportation problem's exceptionally unusual mathematical structure may allow the simplex method to be made incredibly efficient in terms of how to evaluate the necessary simplex method information. Finding an Initial Basic Feasible Solution (IBFS) for the transportation issue can be done using the North-West Corner rule (NWC), the Matrix Minima Method (MMM), and Vogel's Approximation Method. To find a preliminary, straightforward, and feasible answer, apply Vogel's Approximation Method (VAM) [15]. Others had to work hard to come up with modifications to Vogel's Approximation, which was utilized to generate preliminary solutions to transportation problems. Because of confusing decisions, a lack of evidence, and other factors, there are numerous diverse situations in real life. Sometimes obtaining pertinent, precise data for the cost parameter is impossible. A probability distribution's chosen random variables don't always appropriately represent this kind of ambiguous data. The idea of fuzzy sets was put up by Zadeh [17], and it is an essential tool for conveying uncertainty. Chanas and Kuchta [2] offered the best solution for the transportation problem with fuzzy coefficients expressed as fuzzy numbers and developed an algorithm to locate the best answer.

Pandian and Natarajan [11] developed a novel method known as the fuzzy zero point method to find a fuzzy optimal solution for an FTP, where the transportation cost, supply, and demand. Intuitionistic Fuzzy Sets (IFS), a generalization of the fuzzy set notion, were first suggested by Atanassov [1]. Using a single step approach, Nagoorgani and Poonalagu [9] offered a solution to the intuitionistic fuzzy LP problem. [13] Presented to address the challenge of intuitionistic FLP. Uncertainty regarding transportation costs, but demand and supply are represented by triangular intuitionistic fuzzy numbers (TIFNs), according to a new average method Nagoor Gani and Abbas [10] suggested for tackling intuitionistic fuzzy transportation problems. In recent literature, the intuitionistic FTP has received full attention from several scholars [3-5, 7]. [12] Developed a new triangular intuitionistic fuzzy numbers (TIFN) ordering method. [14] A rough membership function shape of the solutions to intuitionistic fuzzy transportation issues was described. [16] Using the ranking approach, the maximization of the intuitionistic triangular fuzzy transportation issue was found. Finding the optimum solution for the imbalanced intuitionistic FTP is the major objective of this effort. In order to solve imbalanced intuitionistic FTP, a new strategy is presented in this study that is both straightforward and simple to understand. The modification distribution mechanism can be replaced with this. This method does not require path tracing. With appropriate numerical examples, the algorithm of the approach is described in depth. By using example problems, further comparisons between the new approach and other current algorithms are developed.

Preliminaries

There are some basic definitions, mathematical operations, and an established method for analyzing TIFN in the following section.

2.1 Definition [3]

If a fuzzy number's membership function is given by, then it is said to be a triangular fuzzy number $\tilde{\kappa} = (\alpha, \beta, \gamma)$

$$\mu_{\tilde{\kappa}} = \begin{cases} \frac{\xi - \alpha}{\alpha - \beta} & \text{if } \alpha \leq \xi \leq \beta \\ \frac{\xi - \gamma}{\gamma - \beta} & \text{if } \beta \leq \xi \leq \gamma \\ 0 & , \quad \text{otherwise} \end{cases}$$





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2.2. Definition [3] A TIFN $\tilde{\mathcal{K}}^{-1}$ is an intuitionistic fuzzy set in $\tilde{\mathcal{K}}$ with the following membership function $\mu_{\tilde{\mathcal{K}}^{-1}}$ and non-membership function $\nu_{\tilde{\mathcal{K}}^{-1}}$ are defined

$$\mu_{\tilde{\mathcal{K}}^{-1}} = \begin{cases} \frac{\xi - \alpha_1}{\alpha_2 - \alpha_1}, & \alpha_1 < \xi \leq \alpha_2 \\ \frac{\alpha_3 - \xi}{\alpha_3 - \alpha_2}, & \alpha_2 \leq \xi < \alpha_3 \\ 0, & \text{otherwise} \end{cases} \text{ and } \nu_{\tilde{\mathcal{K}}^{-1}} = \begin{cases} \frac{\alpha_2 - \xi}{\alpha_2 - \alpha_1}, & \alpha_1 < \xi \leq \alpha_2 \\ \frac{\xi - \alpha_2}{\alpha_3 - \alpha_2}, & \alpha_2 \leq \xi < \alpha_3 \\ 1, & \text{otherwise} \end{cases}$$

Where $\alpha_1^1 \leq \alpha_1 < \alpha_2 < \alpha_3 \leq \alpha_3^1$ this TIFN is denoted by $\tilde{\mathcal{K}}^{-1} = (\alpha_1, \alpha_2, \alpha_3; \alpha_1^1, \alpha_2, \alpha_3^1)$.

2.3. Arithmetic operations

In this part, two TIFNs that are defined on the set of all real numbers are exposed to arithmetic operations. [3, 8].

Let $\tilde{\mathcal{K}}_1^{-1} = (\alpha_1, \alpha_2, \alpha_3; \alpha_1^1, \alpha_2, \alpha_3^1)$ and $\tilde{\mathcal{K}}_2^{-1} = (\beta_1, \beta_2, \beta_3; \beta_1^1, \beta_2, \beta_3^1)$ the following result is reached if there are two TIFN.

1. $\tilde{\mathcal{K}}_1^{-1} + \tilde{\mathcal{K}}_2^{-1} = (\alpha_1 + \beta_1, \alpha_2 + \beta_2, \alpha_3 + \beta_3; \alpha_1^1 + \beta_1^1, \alpha_2 + \beta_2, \alpha_3^1 + \beta_3^1)$
2. $\tilde{\mathcal{K}}_1^{-1} - \tilde{\mathcal{K}}_2^{-1} = (\alpha_1 - \beta_3, \alpha_2 - \beta_2, \alpha_3 - \beta_1; \alpha_1^1 - \beta_3^1, \alpha_2 - \beta_2, \alpha_3^1 - \beta_1^1)$
3. $\tilde{\mathcal{K}}_1^{-1} \times \tilde{\mathcal{K}}_2^{-1} = (\Gamma_1, \Gamma_2, \Gamma_3; \Gamma_1^1, \Gamma_2, \Gamma_3^1)$

Where

$$\Gamma_1 = \min[\alpha_1\beta_1, \alpha_1\beta_3, \alpha_3\beta_1, \alpha_3\beta_3], \Gamma_2 = \alpha_2\beta_2, \Gamma_3 = \max[\alpha_1\beta_1, \alpha_1\beta_3, \alpha_3\beta_1, \alpha_3\beta_3]$$

$$\Gamma_1^1 = \min[\alpha_1^1\beta_1^1, \alpha_1^1\beta_3^1, \alpha_3^1\beta_1^1, \alpha_3^1\beta_3^1], \Gamma_2 = \alpha_2\beta_2, \Gamma_3 = \max[\alpha_1^1\beta_1^1, \alpha_1^1\beta_3^1, \alpha_3^1\beta_1^1, \alpha_3^1\beta_3^1]$$

2.4. Ranking function [3]

If $\tilde{\mathcal{K}}_1^{-1} = (\alpha_1, \alpha_2, \alpha_3; \alpha_1^1, \alpha_2, \alpha_3^1)$ and $\tilde{\mathcal{K}}_2^{-1} = (\beta_1, \beta_2, \beta_3; \beta_1^1, \beta_2, \beta_3^1)$ be two TIFNs then

$$\Re(\tilde{\mathcal{K}}_1^{-1}) = \frac{(\alpha_1 + 2\alpha_2 + \alpha_3) + (\alpha_1^1 + 2\alpha_2 + \alpha_3^1)}{8} \text{ and } \Re(\tilde{\mathcal{K}}_2^{-1}) = \frac{(\beta_1 + 2\beta_2 + \beta_3) + (\beta_1^1 + 2\beta_2 + \beta_3^1)}{8}$$

Proposed Method (PM)

We have a reliable strategy for quickly locating the best solution when using the adopted approach for imbalanced intuitionistic fuzzy transportation issues. The stages listed below can be used to summarize the adopted method.

PM 1. Initialization.

Considering the data provided, create the fuzzy transportation table. Create a balanced solution to an unbalanced, irrational, or FTP.

PM 2. Create the price table.

Reduce rows one by one.

The fuzzy cost table is provided; find the largest element in each row, and subtract it from each element in that row.

Reduce columns one by one.

Find the largest element in each column of the reduced matrix you obtained from PM 2(a), and then remove it from each element in that column. Make sure there is at least one intuitionistic fuzzy zero (IFZ) value in each row and





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column. Select the least value in row (column) and deduct it from the highest cost alone if the reduced matrix produced by PM 2(b) does not contain an IFZ value in either the row or the column.

PM 3. Create an allocation in the matrix of opportunity costs.

1. Determine the cost matrix's greatest unit transportation cost using PM 2 or PM 4.
2. If there are cells that correspond to the i^{th} row and j^{th} column, choose a row single IFZ and/or a column single IFZ cell for allotment.
3. Give the cell the absolute bare minimum of resources, adjust supply and demand, and remove the fulfilled row or column.
4. If the i^{th} row and j^{th} column do not contain a row single IFZ or a column single IFZ cell, choose the next greatest unit transportation cost and proceed as described in PM 3(a) through PM 3(d).

PM 4. Update the table of opportunity costs.

1. After completing PM 3, make sure that each row and column has at least one IFZ. Go to PM 4 (b) if not. If not, proceed to PM 5.
2. Find the lowest element and subtract it from each row (column) if there isn't a single IFZ for each.

PM 5. Selection of the allocation cell.

Repeat PM 3 and 4 as necessary to meet all demand at all destinations and all supply at all sources.

PM 6. Calculate the fuzzy cost table at the starting point, calculate the overall fuzzy transport costs for the realistic allocation.

Remarks

1. Determine the appropriate row and column values and choose the cell allocation with the highest number possible if the values for the largest transportation cost are tied.
2. If there is not a single IFZ in the i^{th} row and j^{th} column of the reduced matrix, select a (row/column) single IFZ for allocation by first selecting the cell with the highest unit transportation cost from the provided imbalanced transportation cost table.

Analytical Examples

Problem 1

The three sources from which the product supply is accessible are listed in Table 1. The demand and supply of the product from each source to each destination, as well as the demand at each of the three destinations, D1, D2, and D3, are represented by three triangular intuitionistic fuzzy numbers. To keep the overall cost of transportation as low as feasible, identify the optimal intuitionistic fuzzy transportation for the products.

Table 1

	D ₁	D ₂	D ₃	Supply (a_i)
S ₁	(1,2,5;0,2,6)	(4,5,9;2,5,13)	(3,4,6;2,4,7)	(4,5,7;3,5,10)
S ₂	(5,6,9;3,6,10)	(2,3,6;1,3,8)	(1,2,3;0,2,4)	(2,6,9;1,6,12)
S ₃	(6,8,11;4,8,12)	(7,9,13;6,9,14)	(1,2,5;0,2,6)	(8,9,12;7,9,13)
Demand (b_j)	(7,8,10;6,8,13)	(4,10,18;2,10,20)	(4,5,7;3,5,10)	

Since, $\sum_{i=1}^3 a_i = (14, 20, 28; 13, 20, 35) \neq \sum_{j=1}^3 b_j = (15, 23, 35; 11, 23, 43)$, so the chosen problem is a unbalanced IFTP.





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Iteration 1. Using PM1, we obtain

	D_1	D_2	D_3	(a_i)
S_1	(1,2,5;0,2,6)	(4,5,9;2,5,13)	(3,4,6;2,4,7)	(4,5,7;3,5,10)
S_2	(5,6,9;3,6,10)	(2,3,6;1,3,8)	(1,2,3;0,2,4)	(2,6,9;1,6,12)
S_3	(6,8,11;4,8,12)	(7,9,13;6,9,14)	(1,2,5;0,2,6)	(8,9,12;7,9,13)
S_4	(0,0,0;0,0,0)	(0,0,0;0,0,0)	(0,0,0;0,0,0)	(1,3,7;0,3,8)
(b_j)	(7,8,10;6,8,13)	(4,10,18;2,10,20)	(4,5,7;3,5,10)	

$$\text{Now, } \sum_{i=1}^4 (15,23,35;11,23,43) = \sum_{j=1}^3 (15,25,35;11,23,43)$$

Iteration 2. Utilize PM2, we obtain

	D_1	D_2	D_3	(a_i)
S_1	(-9,0,9;-17,0,17)	(-6,3,12;-16,3,20)	(-4,6,14;-11,6,19)	(4,5,7;3,5,10)
S_2	(-5,3,12;-11,3,20)	(-8,0,8;-14,0,14)	(-6,3,10;-10,3,15)	(2,6,9;1,6,12)
S_3	(-8,2,12;-14,2,19)	(-7,3,13;-13,3,17)	(-14,0,14;-14,0,14)	(8,9,12;7,9,13)
S_4	(-1,3,8;-4,3,13)	(-8,0,8;-14,0,14)	(-5,4,1;-9,4,9)	(1,3,7;0,3,8)
(b_j)	(7,8,10;6,8,13)	(4,10,18;2,10,20)	(4,5,7;3,5,10)	

Iteration 3. Utilize PM3, we obtain

	D_1	D_2	D_3	(a_i)
S_1	(-9,0,9;-17,0,17) (4,5,7;3,5,10)	(-6,3,12;-16,3,20)	(-4,6,14;-11,6,19)	*
S_2	(-5,3,12;-11,3,20)	(-8,0,8;-14,0,14)	(-6,3,10;-10,3,15)	(2,6,9;1,6,12)
S_3	(-8,2,12;-14,2,19)	(-7,3,13;-13,3,17)	(-14,0,14;-14,0,14)	(8,9,12;7,9,13)
S_4	(-1,3,8;-4,3,13)	(-8,0,8;-14,0,14)	(-5,4,1;-9,4,9)	(1,3,7;0,3,8)
(b_j)	(0,3,6;-4,3,10)	(4,10,18;2,10,20)	(4,5,7;3,5,10)	

Iteration 4. Utilize PM4 and PM5, we obtain

	D_1	D_2	D_3	(a_i)
S_1	(-9,0,9;-17,0,17) (4,5,7;3,5,10)	*	*	*
S_2	*	(-8,0,8;-14,0,14) (2,6,9;1,6,12)	*	*
S_3	(-20,0,20;-33,0,33) (0,3,6;-4,3,10)	(-20,0,20;-30,0,30) (-5,1,8;-13,1,14)	(-14,0,14;-14,0,14) (4,5,7;3,5,10)	*
S_4	*	(-8,0,8;-8,0,8) (1,3,7;0,3,8)	*	*
(b_j)	*	*	*	





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Iteration 5. Utilize PM 6, we obtain.

	D_1	D_2	D_3	(a_i)
S_1	(1,2,5;0,2,6) (4,5,7;3,5,10)	(4,5,9;2,5,13)	(3,4,6;2,4,7)	(4,5,7;5,10)
S_2	(5,6,9;3,6,10)	(2,3,6;1,3,8) (2,6,9;1,6,12)	(1,2,3;0,2,4)	(2,6,9;1,6,12)
S_3	(6,8,11;4,8,12) (0,3,6;-4,3,10)	(7,9,13;6,9,14) (-5,1,8;-13,1,14)	(1,2,5;0,2,6) (4,5,7;3,5,10)	(8,9,12;7,9,13)
(b_j)	(7,8,10;6,8,13)	(4,10,18;2,10,20)	(4,5,7;3,5,10)	

The least expensive fuzzy transportation is

$$= (4,5,7;3,5,10)(1,2,5;0,2,6) + (2,6,9;1,6,12)(2,3,6;1,3,8) + (0,3,6;-4,3,10)(6,8,11;4,8,12) + (-5,1,8;-13,1,14)(7,9,13;4,8,12) + (4,5,7;3,5,10)(1,2,5;0,2,6)$$

$$= (-144, 71, 489; -481, 71, 602)$$

$$\Re(\tilde{\kappa}^{-1}) = 93.75$$

4.2. Problem 2

	D_1	D_2	D_3	(a_i)
S_1	(1,2,4;0,2,9)	(5,7,14;4,7,17)	(13,14,17;12,14,22)	(4,5,7;3,5,10)
S_2	(2,3,5;1,3,8)	(2,3,5;1,3,8)	(1,2,3;0,2,4)	(7,8,10;6,8,11)
S_3	(4,5,7;3,5,10)	(3,4,6;2,4,9)	(5,7,14;4,7,17)	(5,7,10;4,7,13)
S_4	(1,2,3;0,2,4)	(3,6,12;2,6,15)	(1,2,4;0,2,9)	(14,15,19;13,15,20)
(b_j)	(5,7,10;4,7,13)	(8,9,11;7,9,14)	(16,17,22;15,17,23)	

The following table_2 further illustrates our method by comparing the results of the NWCR, MMM, VAM, and MODI Methods with those of our proposed method for ten problems with randomly generated imbalanced intuitionistic FTP. The whole sets of findings for these ten issues are not shown here due to space limitations, but they are available from the author.

Comparison of the various methods of transportation problems. Table_2

S.NO	ROW	COLUMN	NWCR	MMM	VAM	MODI	PROPOSED METHOD
1	4	3	148.88	147	107.25	103.5	93.75
2	4	4	176	158.13	151.38	149.75	142.63
3	3	3	2975	2932.5	2667.5	2529.75	2460
4	3	4	1851.25	1816.25	1765.25	1671.63	1668





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5	4	3	248.75	182.25	157.5	156.25	142
6	3	4	69.75	69.5	63	58.13	53.75
7	4	5	1389	1017.5	1163.5	1014	947.5
8	4	4	121.25	110.25	99.75	97.75	91.25
9	4	5	940.5	824.25	797	790.75	787.25
10	4	5	644.75	632.25	534.63	515.13	514.75

RESULTS AND DISCUSSION

The research and the aforementioned findings make it clear that the proposed method is preferable than our way for dealing with imbalanced intuitionistic fuzzy transportation challenges and has the advantage that it produces the best outcomes.

CONCLUSION

Using triangular intuitionistic fuzzy numbers to represent the product's supply, demand, and transportation costs, this study offers a novel method for resolving the intuitionistic FTP. Therefore, problems with intuitionistic fuzzy transportation that occur in real-world contexts can be solved using this technique.

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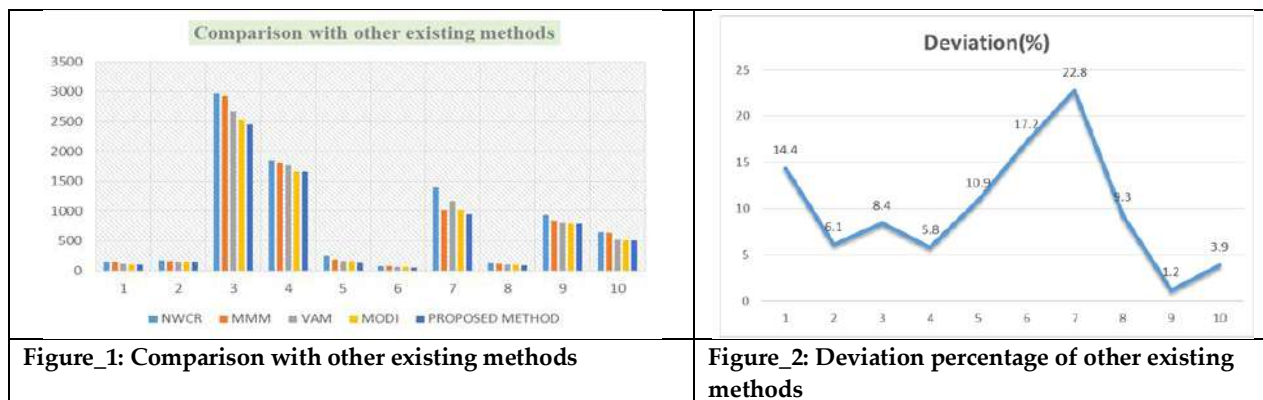
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Cost Analysis of Cold Standby System with Preventive Maintenance and Common Cause Failure

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ABSTRACT

This research defines a cold standby system and obtains its availability and cost also. This system is focused with three types of components failures and failures caused by common causes and preventative maintenance respectively. The primary and standby components' time to failure and time to repair are considered to be exponentially distributed. All of the components have to be repairable on failure. The failure and repair rates for primary and standby components are the same. When the primary component fails, the standby component immediately takes over. Another method for extending the lifespan of systems is preventive maintenance. We present an explicit formula for availability utilizing linear differential equations of the first order and the system's cost function in this work. We compare availability for different values and obtain numerical results as well.

Keywords: Steady-state availability; Common cause failure; Cold standby; Preventive maintenance; Cost function

INTRODUCTION

The reliability and availability of a system are critical in many functional operations such as machines, power plants, internet of things constructions, communications networks, manufacturing systems, and so on. The system's availability is seen as an essential feature in the optimization design selected for such systems, which include more





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dependable components. A system's or its components' dependable structural design is crucial to improving the overall dependability of such systems. Developing an adequate mathematical programming model for such a circumstance has proved beneficial in determining system dependability. Thus, the goal of such challenges is to enhance system availability while balancing restrictions such as time, weight, cost, and so on. As a result, various studies in this field have been conducted. Levitin (2001) concentrated on bringing common-cause failures into the study of non-repairable multistate series-parallel systems. Vaurio (2003) calculated common cause failure probability using a fault tree analysis of a standby safety system with testing scheme and time dependencies. El-Said and El-Sherbeny (2005) investigated the profitability of a two-unit cold backup system with preventative maintenance and random unit changes. Shen *et al.* (2008) investigated the exponential asymptotic behavior of a parallel repaired system with warm standby in the presence of common-cause failure. El-Damcese (2009) explored heated standby systems with common-cause failures and changing breakdown and repair rates over time. Hajeer (2011) obtained the availability of a deteriorating system through inspection, which was prone to common-cause failures and error by human beings. Yusuf *et al.* (2014) investigated the MTSF (mean time to system failure) of a linear sequential 3-out-of-5 warmed backup system with common cause failure. Wang *et al.* (2020) developed availability and preventative maintenance planning for broad time distribution systems. El-Ghamry *et al.* (2022) investigate the serviceability as well as reliability of a k-of-n warm standby system having common-cause failure and imprecise failure and repair rates. Raghav *et al.* (2022) calculated system availability in the context of preventative maintenance.

The information that follows in this research paper is outlined as. Beginning with the introduction in Section 1, Section 2 contains a set of notations and state definitions. The model is described in Section 3. Section 4 deduces the formula for availability. Section 5 discusses the system's cost analysis. The 6th and 7th sections demonstrate the expressions for the availability and profit functions in the absence of maintenance to prevent and a common cause of failure. The findings of our numerical simulations will be presented in Section 8.

System's Notations

The following notations that are used in this system:

α_1 = Type 1 failure rate for the primary component and standby component while functioning

α_2 = Type 2 failure rate for the primary and standby components

α_3 = Type 3 failure rate for the primary component and standby components

β_1 = Type 1 repair rate for both primary and standby components

β_2 = Type 2 repair rate for both primary and standby components

β_3 = Type 3 repair rate for both primary and standby components

λ = Failure rate with regard to common cause

η = Repair rate as a result of common cause

γ = Rate for sending a unit to PM (Preventive Maintenance)

δ = Rate of system reboots at the conclusion of PM

F_{R_1} = The failed component is being repaired at a rate of β_1

F_{R_2} = The failed component is being repaired at a rate of β_2

F_{R_3} = The failed component is being repaired at a rate of β_3

F_{W_1} = The failed component is awaiting repair at rate β_1

F_{W_2} = The failed component is awaiting repair at rate β_2





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F_{W_3} = The failed component is awaiting repair at rate β_3

F_C = Components are immediately failing owing to a common cause at rate λ

O_P = The primary component is governed by PM at a rate of γ

S_P = The standby component is governed by PM at a rate of γ

$P_n(t)$ = The probability that system as a whole is in state n at time t

Model Explanation

The system used in this study has been inspired by nuclear energy plants and systems that generate electricity from renewable sources. The system is examined under the assumption that the time to failure and the time for the replacement of the primary and standby components are exponentially distributed. We examine a cold standby system that work with two components initially. One of the components has been set up as primary, while the other as cold standby. The primary working component can break down in three ways with failure rates α_1 , α_2 and α_3 respectively. All components are considered as repairable. There is a common cause failure with failure rate λ and repair rate η . When a primary component fails with rate α_1 , it is repaired with rate β_1 similarly, when primary unit fails with α_2 , it is repaired with rate β_2 and when primary component fails with rate α_3 , it is repaired with rate β_3 . The system also includes a preventative maintenance with rate γ , and after preventative maintenance, the system is restarted for work with rate δ . According to the transition rate diagram, state S_0 is the initial and working state, whereas states S_1 , S_2 and S_3 are the operational states in the event that one component fails and cold standby component is replaced by failed component. The failed states are S_4 , S_5 , S_6 , S_7 , S_8 , S_9 , S_{10} , S_{11} , S_{12} and S_{14} . There is a preventative maintenance state S_{13} . For all failure categories, repair and failure rates for the system as a whole remains constant.

Availability Exploration

We have the following initial condition

$$P(0) = [P_0(0), P_1(0), P_2(0), P_3(0), P_4(0), P_5(0), P_6(0), P_7(0), P_8(0), P_9(0), P_{10}(0), P_{11}(0), P_{12}(0), P_{13}(0), P_{14}(0)] \\ = [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]$$

The differential-difference equations of each state are given following.

$$P_0'(t) = -(\alpha_1 + \alpha_2 + \alpha_3 + \lambda + \gamma)P_0(t) + \beta_1 P_1(t) + \beta_2 P_2(t) + \beta_3 P_3(t) + \delta P_{13}(t) + \eta P_{14}(t) \quad (1)$$

$$P_1'(t) = -(\alpha_1 + \alpha_2 + \alpha_3 + \beta_1)P_1(t) + \alpha_1 P_0(t) + \beta_1 P_4(t) + \beta_2 P_7(t) + \beta_3 P_{10}(t) \quad (2)$$

$$P_2'(t) = -(\alpha_1 + \alpha_2 + \alpha_3 + \beta_2)P_2(t) + \alpha_2 P_0(t) + \beta_1 P_5(t) + \beta_2 P_8(t) + \beta_3 P_{11}(t) \quad (3)$$

$$P_3'(t) = -(\alpha_1 + \alpha_2 + \alpha_3 + \beta_3)P_3(t) + \alpha_3 P_0(t) + \beta_1 P_6(t) + \beta_2 P_9(t) + \beta_3 P_{12}(t) \quad (4)$$

$$P_4'(t) = \alpha_1 P_1(t) - \beta_1 P_4(t) \quad (5)$$

$$P_5'(t) = \alpha_1 P_2(t) - \beta_1 P_5(t) \quad (6)$$

$$P_6'(t) = \alpha_1 P_3(t) - \beta_1 P_6(t) \quad (7)$$

$$P_7'(t) = \alpha_2 P_1(t) - \beta_2 P_7(t) \quad (8)$$

$$P_8'(t) = \alpha_2 P_2(t) - \beta_2 P_8(t) \quad (9)$$

$$P_9'(t) = \alpha_2 P_3(t) - \beta_2 P_9(t) \quad (10)$$





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$$P_{10}'(t) = \alpha_3 P_1(t) - \beta_3 P_{10}(t) \quad (11)$$

$$P_{11}'(t) = \alpha_3 P_2(t) - \beta_3 P_{11}(t) \quad (12)$$

$$P_{12}'(t) = \alpha_3 P_3(t) - \beta_3 P_{12}(t) \quad (13)$$

$$P_{13}'(t) = \gamma P_0(t) - \delta P_{13}(t) \quad (14)$$

$$P_{14}'(t) = \lambda P_0(t) - \eta P_{14}(t) \quad (15)$$

All derivatives have been become nil in steady-state,

$$-(\alpha_1 + \alpha_2 + \alpha_3 + \lambda + \gamma)P_0(t) + \beta_1 P_1(t) + \beta_2 P_2(t) + \beta_3 P_3(t) + \delta P_{13}(t) + \eta P_{14}(t) = 0 \quad (16)$$

$$-(\alpha_1 + \alpha_2 + \alpha_3 + \beta_1)P_1(t) + \alpha_1 P_0(t) + \beta_1 P_4(t) + \beta_2 P_7(t) + \beta_3 P_{10}(t) = 0 \quad (17)$$

$$-(\alpha_1 + \alpha_2 + \alpha_3 + \beta_2)P_2(t) + \alpha_2 P_0(t) + \beta_1 P_5(t) + \beta_2 P_8(t) + \beta_3 P_{11}(t) = 0 \quad (18)$$

$$-(\alpha_1 + \alpha_2 + \alpha_3 + \beta_3)P_3(t) + \alpha_3 P_0(t) + \beta_1 P_6(t) + \beta_2 P_9(t) + \beta_3 P_{12}(t) = 0 \quad (19)$$

$$\alpha_1 P_1(t) - \beta_1 P_4(t) = 0 \quad (20)$$

$$\alpha_1 P_2(t) - \beta_1 P_5(t) = 0 \quad (21)$$

$$\alpha_1 P_3(t) - \beta_1 P_6(t) = 0 \quad (22)$$

$$\alpha_2 P_1(t) - \beta_2 P_7(t) = 0 \quad (23)$$

$$\alpha_2 P_2(t) - \beta_2 P_8(t) = 0 \quad (24)$$

$$\alpha_2 P_3(t) - \beta_2 P_9(t) = 0 \quad (25)$$

$$\alpha_3 P_1(t) - \beta_3 P_{10}(t) = 0 \quad (26)$$

$$\alpha_3 P_2(t) - \beta_3 P_{11}(t) = 0 \quad (27)$$

$$\alpha_3 P_3(t) - \beta_3 P_{12}(t) = 0 \quad (28)$$

$$\gamma P_0(t) - \delta P_{13}(t) = 0 \quad (29)$$

$$\lambda P_0(t) - \eta P_{14}(t) = 0 \quad (30)$$

We get from equations (20) – (30).

$$P_4(t) = \frac{\alpha_1}{\beta_1} P_1(t) \quad (31)$$

$$P_5(t) = \frac{\alpha_1}{\beta_1} P_2(t) \quad (32)$$

$$P_6(t) = \frac{\alpha_1}{\beta_1} P_3(t) \quad (33)$$

$$P_7(t) = \frac{\alpha_2}{\beta_2} P_1(t) \quad (34)$$

$$P_8(t) = \frac{\alpha_2}{\beta_2} P_2(t) \quad (35)$$

$$P_9(t) = \frac{\alpha_2}{\beta_2} P_3(t) \quad (36)$$





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$$P_{10}(t) = \frac{\alpha_3}{\beta_3} P_1(t) \quad (37)$$

$$P_{11}(t) = \frac{\alpha_3}{\beta_3} P_2(t) \quad (38)$$

$$P_{12}(t) = \frac{\alpha_3}{\beta_3} P_3(t) \quad (39)$$

$$P_{13}(t) = \frac{\gamma}{\delta} P_0(t) \quad (40)$$

$$P_{14}(t) = \frac{\lambda}{\eta} P_0(t) \quad (41)$$

Putting equations (31), (34) and (37) into equation (17), we obtain.

$$P_1(t) = \frac{\alpha_1}{\beta_1} P_0(t) \quad (42)$$

Substituting equations (32), (35) and (38) into equation (18), we get.

$$P_2(t) = \frac{\alpha_2}{\beta_2} P_0(t) \quad (43)$$

After Putting equations (33), (36) and (39) into equation (19), we get.

$$P_3(t) = \frac{\alpha_3}{\beta_3} P_0(t) \quad (44)$$

After substituting the value of $P_1(t)$ from equation (42) into equations (31), (34) and (37), we get the following results.

$$P_4(t) = \frac{\alpha_1^2}{\beta_1^2} P_0(t) \quad (45)$$

$$P_7(t) = \frac{\alpha_1 \alpha_2}{\beta_1 \beta_2} P_0(t) \quad (46)$$

$$P_{10}(t) = \frac{\alpha_1 \alpha_3}{\beta_1 \beta_3} P_0(t) \quad (47)$$

Similarly, after putting the value of $P_2(t)$ from equation (43) into equations (32), (35) and (38), we obtain.

$$P_5(t) = \frac{\alpha_1 \alpha_2}{\beta_1 \beta_2} P_0(t) \quad (48)$$

$$P_8(t) = \frac{\alpha_2^2}{\beta_2^2} P_0(t) \quad (49)$$

$$P_{11}(t) = \frac{\alpha_2 \alpha_3}{\beta_2 \beta_3} P_0(t) \quad (50)$$

In a similar manner, after substituting the value of $P_3(t)$ from equation (44) into equations (33), (36) and (39), we have.





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$$P_6(t) = \frac{\alpha_1 \alpha_3}{\beta_1 \beta_3} P_0(t) \quad (51)$$

$$P_9(t) = \frac{\alpha_2 \alpha_3}{\beta_2 \beta_3} P_0(t) \quad (52)$$

$$P_{12}(t) = \frac{\alpha_3^2}{\beta_3^2} P_0(t) \quad (53)$$

Normalizing condition:

$$P_0(t) + P_1(t) + P_2(t) + P_3(t) + P_4(t) + P_5(t) + P_6(t) + P_7(t) + P_8(t) + P_9(t) + P_{10}(t) + P_{11}(t) + P_{12}(t) + P_{13}(t) + P_{14}(t) = 1 \quad (54)$$

After putting the values of equations (40) - (53) into the above normalizing condition, we get.

$$P_0(t) = \frac{\beta_1^2 \beta_2^2 \beta_3^2 \delta \eta}{T} \quad (55)$$

Where,

$$T = \left[\beta_1^2 \beta_2^2 \beta_3^2 (\delta \eta + \gamma \eta + \lambda \delta) + \delta \eta \left\{ \alpha_1 \beta_2 \beta_3^2 (\beta_1 \beta_2 + \alpha_1 \beta_2 + 2\alpha_2 \beta_1) + \alpha_2 \beta_1^2 \beta_3 (\beta_2 \beta_3 + \alpha_2 \beta_3 + 2\alpha_3 \beta_2) + \alpha_3 \beta_1 \beta_2^2 (\beta_1 \beta_2 + \alpha_1 \beta_2 + 2\alpha_2 \beta_1) \right\} \right]$$

Each state has steady-state probabilities in term of $P_0(t)$ as follows.

$$P_1(t) = \frac{\alpha_1 \beta_1 \beta_2^2 \beta_3^2 \delta \eta}{T} \quad (56)$$

$$P_2(t) = \frac{\alpha_2 \beta_1^2 \beta_2 \beta_3^2 \delta \eta}{T} \quad (57)$$

$$P_3(t) = \frac{\alpha_3 \beta_1^2 \beta_2^2 \beta_3 \delta \eta}{T} \quad (58)$$

$$P_4(t) = \frac{\alpha_1^2 \beta_2^2 \beta_3^2 \delta \eta}{T} \quad (59)$$

$$P_5(t) = \frac{\alpha_1 \alpha_2 \beta_1 \beta_2 \beta_3^2 \delta \eta}{T} \quad (60)$$

$$P_7(t) = \frac{\alpha_1 \alpha_3 \beta_1 \beta_2^2 \beta_3 \delta \eta}{T} \quad (61)$$

$$P_5(t) = \frac{\alpha_1 \alpha_2 \beta_1 \beta_2 \beta_3^2 \delta \eta}{T} \quad (62)$$

$$P_8(t) = \frac{\alpha_2^2 \beta_1^2 \beta_3^2 \delta \eta}{T} \quad (63)$$

$$P_9(t) = \frac{\alpha_2 \alpha_3 \beta_1^2 \beta_2 \beta_3 \delta \eta}{T} \quad (64)$$





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$$P_{10}(t) = \frac{\alpha_1 \alpha_3 \beta_1 \beta_2^2 \beta_3 \delta \eta}{T} \quad (65)$$

$$P_{11}(t) = \frac{\alpha_2 \alpha_3 \beta_1 \beta_2^2 \beta_3 \delta \eta}{T} \quad (66)$$

$$P_{12}(t) = \frac{\alpha_3^2 \beta_1^2 \beta_3^2 \delta \eta}{T} \quad (67)$$

$$P_{13}(t) = \frac{\beta_1^2 \beta_2^2 \beta_3^2 \gamma \eta}{T} \quad (68)$$

$$P_{14}(t) = \frac{\beta_1^2 \beta_2^2 \beta_3^2 \lambda \delta}{T} \quad (69)$$

Steady - state availability can be calculated in the following way,

$$A_v(\infty) = P_0(t) + P_1(t) + P_2(t) + P_3(t) + P_{13}(t) \quad (70)$$

Now putting the equations from (55) - (58), and (68) into equation (70), we get.

$$A_v(\infty) = \frac{\beta_1 \beta_2 \beta_3 \eta \{ \beta_1 \beta_2 \beta_3 (\delta + \gamma) + \delta (\alpha_1 \beta_2 \beta_3 + \alpha_2 \beta_1 \beta_3 + \alpha_3 \beta_1 \beta_2) \}}{T} \quad (71)$$

1. Analysis of Cost

1.1 Busy Period's Analysis

The steady-state busy period B is obtained as following:

$$B = 1 - (P_0(t) + P_{13}(t)) \quad (72)$$

Now we get the following value after yielding the values of $P_0(t)$ and $P_{13}(t)$ into equation (72)

$$B = 1 - \frac{\beta_1^2 \beta_2^2 \beta_3^2 \eta (\delta + \gamma)}{T} \quad (73)$$

5.2 Expected Frequency of PM (Preventive Maintenance)

The frequency of preventative maintenance expected for a given period of time is defined by:

$$K = P_{13}(t) = \frac{\beta_1^2 \beta_2^2 \beta_3^2 \gamma \eta}{T} \quad (74)$$

In the steady state, the following equation predicts the total gain (profit) based on the amount of time invested by the system:

$$\text{Profit} = \text{Total revenue} - \text{Total cost}$$

$$PF = R \cdot A - C_1 \cdot B - C_2 \cdot K \quad (75)$$

Here

PF is the profit made by the system.

R indicates the system's profit per unit of uptime.

C_1 denotes the cost per unit hour for repairing the system.

C_2 shows the cost of each and every preventative maintenance item.

After inserting equations (71), (73), and (74) into equation (75), we find the final outcome as given below.

$$PF = \frac{\left[R \beta_1 \beta_2 \beta_3 \eta \{ \beta_1 \beta_2 \beta_3 (\delta + \gamma) + \delta (\alpha_1 \beta_2 \beta_3 + \alpha_2 \beta_1 \beta_3 + \alpha_3 \beta_1 \beta_2) \} - C_1 \{ T - \beta_1^2 \beta_2^2 \beta_3^2 \eta (\delta + \gamma) \} \right] - C_2 \beta_1^2 \beta_2^2 \beta_3^2 \gamma \eta}{T} \quad (76)$$

Cost analysis when preventive maintenance and common cause failure is not available:





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Without preventive maintenance

According to this measure, $\gamma = 0$ and $\delta = 1$, we obtain

Steady-state availability is calculated as

$$A_v(\infty) = \frac{\beta_1 \beta_2 \beta_3 \eta \{ \beta_1 \beta_2 \beta_3 + \alpha_1 \beta_2 \beta_3 + \alpha_2 \beta_1 \beta_3 + \alpha_3 \beta_1 \beta_2 \}}{T_1} \quad (77)$$

$$\text{Where, } T_1 = \left[\beta_1^2 \beta_2^2 \beta_3^2 (\eta + \lambda) + \eta \left\{ \alpha_1 \beta_2 \beta_3^2 (\beta_1 \beta_2 + \alpha_1 \beta_2 + 2\alpha_2 \beta_1) + \alpha_2 \beta_1^2 \beta_3 (\beta_2 \beta_3 + \alpha_2 \beta_3 + 2\alpha_3 \beta_2) \right. \right. \\ \left. \left. + \alpha_3 \beta_1 \beta_2^2 (\beta_1 \beta_2 + \alpha_1 \beta_2 + 2\alpha_2 \beta_1) \right\} \right]$$

The steady-state busy time B is determined by carrying out the following step:

$$B = 1 - \frac{\beta_1^2 \beta_2^2 \beta_3^2 \eta}{T_1} \quad (78)$$

The predicted frequency without preventative maintenance is $K = 0$, hence the total profit incurred by the system in

$$\text{steady state is } PF = R \cdot A - C_1 \cdot B \quad PF = \left[\frac{R \beta_1 \beta_2 \beta_3 \eta \{ \beta_1 \beta_2 \beta_3 + \alpha_1 \beta_2 \beta_3 + \alpha_2 \beta_1 \beta_3 + \alpha_3 \beta_1 \beta_2 \} - C_1 \{ T_1 - \beta_1^2 \beta_2^2 \beta_3^2 \eta \}}{T_1} \right] \quad (79)$$

Without common cause failure

In this specific case, $\lambda = 0$ and $\eta = 1$,

Steady-state availability is calculated as

$$A_v(\infty) = \frac{\beta_1 \beta_2 \beta_3 \{ \beta_1 \beta_2 \beta_3 (\delta + \gamma) + \delta (\alpha_1 \beta_2 \beta_3 + \alpha_2 \beta_1 \beta_3 + \alpha_3 \beta_1 \beta_2) \}}{T_2} \quad (80)$$

$$\text{Where, } T_2 = \left[\beta_1^2 \beta_2^2 \beta_3^2 (\delta + \gamma) + \delta \left\{ \alpha_1 \beta_2 \beta_3^2 (\beta_1 \beta_2 + \alpha_1 \beta_2 + 2\alpha_2 \beta_1) + \alpha_2 \beta_1^2 \beta_3 (\beta_2 \beta_3 + \alpha_2 \beta_3 + 2\alpha_3 \beta_2) \right. \right. \\ \left. \left. + \alpha_3 \beta_1 \beta_2^2 (\beta_1 \beta_2 + \alpha_1 \beta_2 + 2\alpha_2 \beta_1) \right\} \right]$$

The steady-state busy time B without common cause failure is computed as follows:

$$B = 1 - \frac{\beta_1^2 \beta_2^2 \beta_3^2 (\delta + \gamma)}{T_2} \quad (81)$$

The predicted frequency without common cause failure $K = \frac{\beta_1^2 \beta_2^2 \beta_3^2 \gamma}{T_2}$,

Thus, the estimate of the total profit generated as the system as a whole in the steady state is derived by

$$PF = R \cdot A - C_1 \cdot B - C_2 \cdot K \\ PF = \left[\frac{R \beta_1 \beta_2 \beta_3 \{ \beta_1 \beta_2 \beta_3 (\delta + \gamma) + \delta (\alpha_1 \beta_2 \beta_3 + \alpha_2 \beta_1 \beta_3 + \alpha_3 \beta_1 \beta_2) \} - C_1 \{ T_2 - \beta_1^2 \beta_2^2 \beta_3^2 (\delta + \gamma) \} - C_2 \beta_1^2 \beta_2^2 \beta_3^2 \gamma}{T_2} \right] \quad (82)$$

Numerical Results

We present a numerical example to assist you better understand the role of PM (preventative maintenance) and common cause failure in the structure of the system. We take into account the following values for this we vary the value of α_1 in case 1, α_2 in case 2 and α_3 in case 3 and fix other parameters as $\beta_1 = 0.5$, $\beta_2 = 0.6$, $\beta_3 = 0.8$, $R = 2000$, $C_1 = 200$, $C_2 = 60$, $\gamma = 0.3$, $\delta = 0.007$, $\lambda = 0.002$, $\eta = 0.008$





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We are given following tables of numerical computation.

CONCLUSION

In the present research, we establish a cold standby system that has two components. The paper gives precise formulas for steady-state availability and profit function. All of these expressions are compared between those with and without preventative maintenance, and they are also compared with and without common cause failures. The numerical results illustrate how type 1, type 2 and type 3 failure rates affect steady-state availability and profit function. These data imply that enhanced system component maintenance resulted in increased system availability and performance. The system with preventive maintenance outperforms the system without preventive maintenance in terms of steady-state availability and profit function, while the system without common cause failure outperforms the system with common cause failure.

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Table – a Case 1 (a): Comparison of availability and profit (with and without P.M.) according to type 1 failure.

α_1	A_v with P. M.	A_v without P. M.	Profit analyses with P. M.	Profit analyses without P. M.
0.002	0.999253056	0.659244573	986.8382247	796.6545697
0.004	0.999248801	0.659235834	986.8379648	796.6298785
0.006	0.999186348	0.659222832	986.8379354	796.6286459
0.008	0.999148592	0.659175827	986.83792	796.6179534
0.01	0.999135679	0.659164501	986.8378964	796.6056352
0.012	0.999096756	0.659162004	986.8378857	796.6052654
0.014	0.99906596	0.659160589	986.8378845	796.6043524
0.016	0.999056784	0.659159843	986.8378564	796.6041654





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0.018	0.999055967	0.659156999	986.8378468	796.6040834
0.02	0.999055759	0.659155637	986.8378347	796.6039564

Table – b Case 1 (b): Comparison of availability and profit (with and without CCF) according to type 1 failure

α_1	A_v with CCF	A_v without CCF	Profit analyses with CCF	Profit analyses without CCF
0.002	0.999253056	0.998876524	986.8382247	1008.9654426
0.004	0.999248801	0.998875963	986.8379648	1008.9549478
0.006	0.999186348	0.99887557	986.8379354	1008.9446752
0.008	0.999148592	0.998874362	986.83792	1008.93734
0.01	0.999135679	0.998874251	986.8378964	1008.9214435
0.012	0.999096756	0.998874005	986.8378857	1008.9146751
0.014	0.99906596	0.998873824	986.8378845	1008.9026752
0.016	0.999056784	0.998872496	986.8378564	1008.9065495
0.018	0.999055967	0.998872325	986.8378468	1008.8945867
0.02	0.999055759	0.998872240	986.8378347	1008.8900654

Table – c Case 2 (a): Comparison of availability and profit (with and without P.M.) according to type 2 failure.

α_2	A_v with P. M.	A_v without P. M.	Profit analyses with P. M.	Profit analyses without P. M.
0.002	0.998275432	0.695654236	987.8645768	797.9536257
0.004	0.998272851	0.695645258	987.86638274	797.9532469
0.006	0.998272184	0.695643824	987.8631489	797.9531582
0.008	0.998271845	0.695642938	987.86305	797.9531484
0.01	0.99827155	0.695641642	987.8625438	797.9529838
0.012	0.998270381	0.695639497	987.8622459	797.9528845
0.014	0.998269867	0.695638864	987.8619476	797.9526738
0.016	0.998268754	0.695638568	987.8618438	797.9521975
0.018	0.998268439	0.695637757	987.8618426	797.9520478
0.02	0.998267693	0.695637642	987.8616753	797.9519849

Table – d Case 2 (b): Comparison of availability and profit (with and without CCF) according to type 2 failure.

α_2	A_v with CCF	A_v without CCF	Profit analyses with CCF	Profit analyses without CCF
0.002	0.999375432	0.999668252	987.8645768	1112.8964362
0.004	0.999372851	0.99966558	987.86638274	1112.8546287
0.006	0.999372184	0.999663538	987.8631489	1112.8458823
0.008	0.999371845	0.999662352	987.86305	1112.8348321
0.01	0.99937155	0.999660253	987.8625438	1112.8342864
0.012	0.999370381	0.999659552	987.8622459	1112.8384392
0.014	0.999369867	0.999655096	987.8619476	1112.8265238
0.016	0.999368754	0.999652048	987.8618438	1112.8053197
0.018	0.999368439	0.99964854	987.8618426	1112.7882003
0.02	0.999367693	0.999645098	987.8616753	1112.7540863





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Table – e Case 3 (a): Comparison of availability and profit (with and without P.M.) according to type 3 failure

α_3	A_v with P. M.	A_v without P. M.	Profit analyses with P. M.	Profit analyses without P. M.
0.002	0.999564576	0.757586495	995.8889495	801.9585493
0.004	0.999528538	0.756943458	995.887556	801.9583678
0.006	0.999525465	0.756873763	995.8872465	801.9583153
0.008	0.999519829	0.756549497	995.88698	801.9582846
0.01	0.99951543	0.75635688	995.8868432	801.9582458
0.012	0.999512493	0.756246827	995.8865384	801.9581493
0.014	0.999505765	0.756185364	995.8862538	801.9578395
0.016	0.999549863	0.756054682	995.8860492	801.9576849
0.018	0.999548497	0.755976358	995.8859438	801.9575486
0.02	0.999547568	0.755846376	995.8855483	801.9572464

Table – f Case 3 (b): Comparison of availability and profit (with and without CCF) according to type 3 failure

α_3	A_v with CCF	A_v without CCF	Profit analyses with CCF	Profit analyses without CCF
0.002	0.999564576	0.999753069	995.8889495	1124.9808642
0.004	0.999528538	0.999752034	995.887556	1124.9745792
0.006	0.999525465	0.999749862	995.8872465	1124.9738543
0.008	0.999519829	0.999745793	995.88698	1124.9686378
0.01	0.99951543	0.999742681	995.8868432	1124.9549352
0.012	0.999512493	0.999741628	995.8865384	1124.9538945
0.014	0.999505765	0.999738607	995.8862538	1124.9406739
0.016	0.999549863	0.999736785	995.8860492	1124.9346576
0.018	0.999548497	0.99976243	995.8859438	1124.9286483
0.02	0.999547568	0.99974846	995.8855483	1124.9049753





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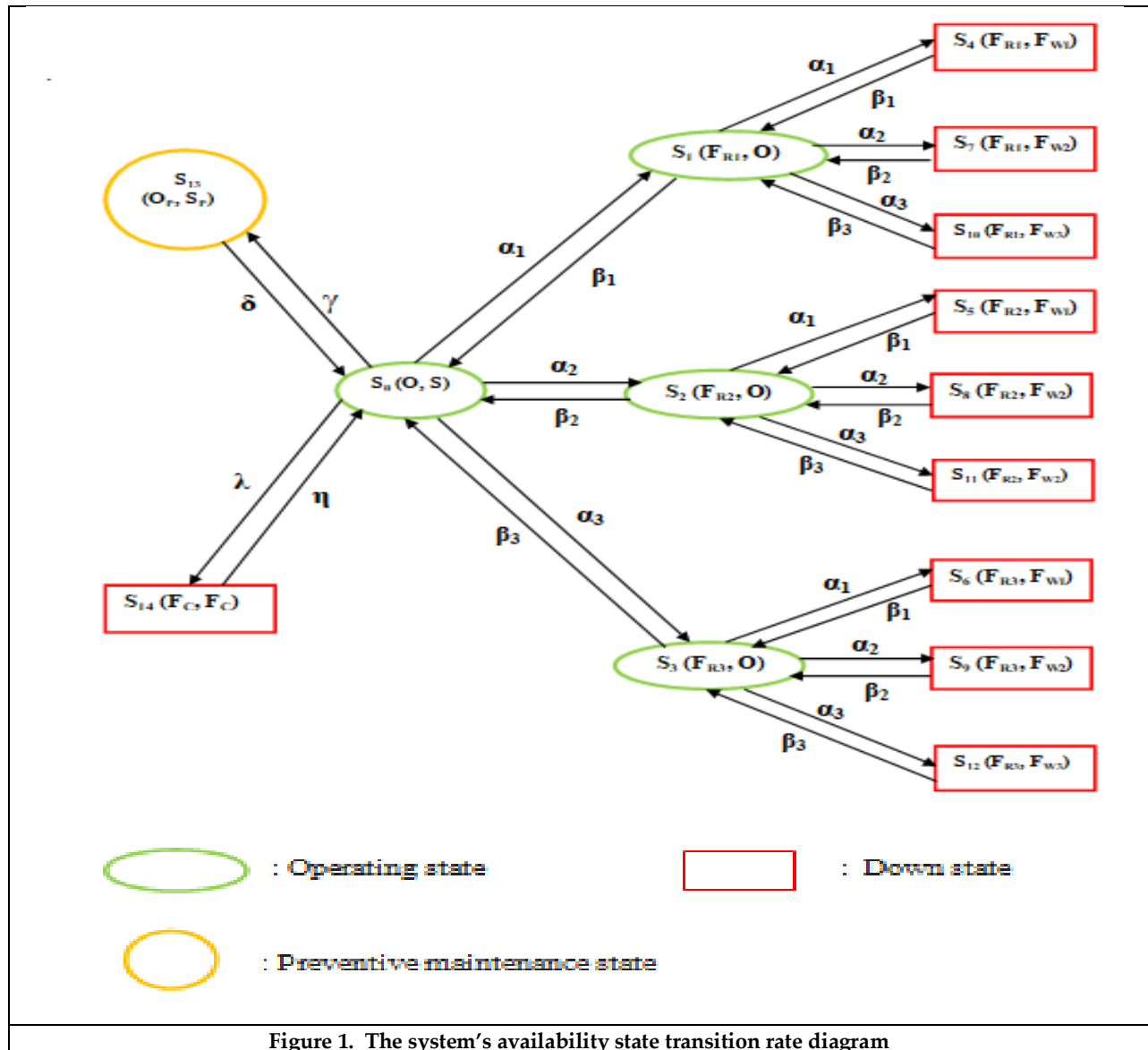


Figure 1. The system's availability state transition rate diagram

