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RESEARCH ARTICLE

An Ayurvedic Management of Amvata: A Case Study

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ABSTRACT

Ayurvedic medicine, which has its roots in Indian Vedic culture, is a science of life that places a greater emphasis on prevention than on curative measures. Its knowledge is expressed in concise and meaningful code known as a Sutra, which is what makes Ayurved so beautiful and timeless. Aamvata is a common disease in society, where vitiation of Vata and accumulation of Aam are major pathogenesis; females are more susceptible to Aamvata than males. In modern medicine, there is no guaranteed treatment that can completely cure a patient; all medications only provide temporary relief. In cases like these, Ayurvedic medicine yields the best results, curing diseases from their core. In the current study, an herbal medication including Tikta& Katu rasa and Dipana qualities as Shaman Chikitsa with Langhana, Swedana, and Virechana was used to treat a female patient with features of Aamvata. During the course of treatment, no complications were discovered. The patient had relief in just two days, and after 28 days, there was a noticeable improvement in the symptoms. Ayurvedic treatment targets the underlying causes of Aamvata pathology, and breakage of Samparpti is the best treatment for Aamvata.

Keywords: Aamvata, Vata, Shaman Chikitsa, Virechana, Dipana.





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INTRODUCTION

Aamvata is first mentioned as a separate disease in Madhav Nidana, where it is stated that Agnimandya plays a central role in the manifestation of the disease.[1] This theory is very well supported by the view of Acharya Vagbhatta that the main cause of all diseases is Agnimandya.[2] Acharya Madhava has described the most characteristic feature of this disease: severe pain similar to a scorpion bite. Asthi and Sandhi are the chief sites of presentation of the cardinal symptoms such as Sandhishoola, Sandhigraha, Sandhi Sotha, etc. These symptoms resemble the cardinal features of rheumatoid arthritis, i.e., pain, swelling, stiffness, fever, general debility, etc. Rheumatoid arthritis is a chronic immuno-inflammatory systemic disease that affects mainly the synovial joints, with a possibility of extra articular manifestations Many joint disorders are discovered in everyday OPDs. The second most prevalent condition among all joint diseases is Aamvata. It is more prevalent in females than in males. The most typical signs and symptoms of Aamvata are joint discomfort and swelling. The Aamvata's Nidan Panchaka, or cause, pathophysiology, symptoms, therapy, and complications, is provided by Madhavnidana [3]. Most of the time, people with Aamvata experience restrictions because of joint pain and edema. The Chikitsa Siddhant of Aamvata is described by Aacharya Chakradutta [4]. The anguish experienced by Aamvata is compared in the Samhita to that of scorpion stings (Vrushik Dansh Vat Vedana).

CASE REPORT

A 48-year-old female came to OPD with C/O -

- i. Ubhaya Janu Sandhi Shool-Shotha (Bilateral knee pain & swelling)
- ii. Ubhaya Parva Sandhi Shool (Bilateral finger joints pain)
- iii. Ubhaya Ansa-Kurpara Sandhi Shool
- iv. Ubhaya ManibandhaShool, Shotha & Sparsha-Asahatwa
- v. Angamarda (Malaise)
- vi. Morning stiffness of all joints
- vii. Aruchi(Anorexia)

For two years, the patient has complained about the above.

History of Past Illness & its Treatment

- a. H/o Chikungunya 2 years before.
- b. H/o HTN Tab.Telvas(40 mg) 1-0-0

History of Personal Illness

Two years ago, the patient was normal. From that point on, the patient has experienced the following symptoms: Angamarda (malaise), Aruchi (Anorexia), Morning stiffness, Ansa-Kurpara Sandhi Shool, Ubhaya ManibandhaShool, bilateral finger joints pain, and bilateral knee joint pain and swelling [5]. After receiving only brief relief from several western doctors, the patient chose to receive Ayurvedic treatment. So, she came to our Centre for pure Ayurvedic treatment.

Personal History

Occupation: Housewife.

Diet: Veg. diet.

Appetite: Decreased.

Allergy: No history of any drug or food allergy.

Bad Habits: No.

Ashtavidh-Pariksha

- 1) Nadi (pulse): 78/min
- 2) Mala (stool): Malavashtmbha (constipated)





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- 3) Mutra (urine): Prakrut (regular)
- 4) Jihwa (tongue): Sama (coated)
- 5) Shabda (voice): Prakrut (clear)
- 6) Sparsha (touch): Anushna (normal)
- 7) Drik (eyes): Prakrut (normal)
- 8) Akriti (built): Sthul (obey).

Dashavidha-Parikshna

- 1) Prakruti (constitution): Kapha Pradhana-Vata Anubandhi.
- 2) Vikruti (morbidities): Dosha- Vatapradhanatridosha, Dushya- Rasa, Meda, Ashti.
- 3) Satva (psychic conditions): Avara.
- 4) Sara (excellence of tissue elements): Mamsa
- 5) Samhanana (compactness of organs): Madhyama
- 6) Pramana (measurement of organs): Madhyama
- 7) Satmya (homologation): Sarva Rasa
- 8) Aharasakti (power of intake & digestion of food): Avara
- 9) Vyayamasakti (power of performing exercise): Avara
- 10) Vaya (age): 48 years.

MATERIAL AND METHODS

Material (Tables 1 & 2)

Method

- A. Center of study: Vinayak Ayurved & Panchakarma Clinic
- B. Type of study: Simple Random Single Case Study

Assessment Criteria [6][7] (Tables 3-5):

DISCUSSION

Discussion on Vhyadhi Aamvata is the result of both the vitiation of Vata Dosha and the production of Aam. According to Ayurved, Agnimandya is the primary cause of most diseases, or "Roga sraveapimandagnau." The primary source of Aam production is this Agnimandya [8]. The purpose of Aamvata treatment, in addition to Vatahara treatment, was to eliminate Ama and improve Jathra-agani. According to Yogaratnakara, the greatest treatment for Aam is Langhana. We gave the patient advice on Langhana in the form of Laghu Aahar. Aamvata is a RasajaVikara and an Amashayottha Vyadhi. In such cases, Langhana is the primary line of treatment [9].

Hetu of Aamvata

Ahar

- i. Improper and irregular diet causes the disturbance of Vata Dosha.
- ii. Dry foods like biscuit and all bakery products.
- iii. Sabudana, Dadhi
- iv. Paryushita Anna
- v. Grains: Navadhanyak (Daily plenty of rice in diet).
- vi. Daily non-veg (mutton & chicken)

Vihar

• Working in water





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- Suppression of natural urges (Mala-Muta Vega Dharan)
- Diwaswap
- Manasika Nidan- Chinta and Vegavrodha causes Vata Vrudhi (Table 6)

All of the aforementioned Hetu (causes) cause the body to produce Ama, which circulates throughout the entire body (via Vyan-Vayu) and builds up in the joints, or Sandhi, in conjunction with the pathogenicity or vitiation of Vata, which results in Aamvata.

Discussion on Medicine (Breakage of Samprapti)

Yograj Guggulu- It acts significantly on vitiated Kapha and Vata doshas. The majority of the medications in this formulation are Tikta in Rasa, Ushna Virya, and Katu, which have antagonistic qualities against Ama and Kapha, which are the main causes of RA. Owing to Tikshna Ushna and Ruksha Guna, the vitiated Vata and Kapha are subdued, and the Ama is prevented from remaining at the Pathogenesis site and from producing srotorodha.[10]

Vatagajankush Rasa- The mixture of Sonth, Marich, and Pippali acts as a deepan and enhances digestion as Aam Pachan. The properties of vatsnabh, vikasi, vyavayi, and yogvahi facilitate simple digestion of all the medications in Vatagajankushras. It is easily accessible at the cellular level and opens all microchannels. Along with working as Deepan, Vatanulomak, Kapha nissarak, and Vatashamak, Hritaki, Agnimanth, and Karkatshrangi Agni is increased by all Ras-Bhasmas, namely Jatharagni, Dhatwagni, and Bhutagni. Works as Balya, Rasayan, Vata pradhanTridosh Shamak. Thus, it is demonstrating that this Vatgajankushras can be used in conjunction with Kapha or Pitta Dosh Prakop, particularly in Vata Pradhan Vyadhi. It is Aam Pachak, Dhatupushtikarak, Baly Rasyana, Brimhan, and Vata Pradhan Tridosh Shamak. [11]

MaharasnadiKwath- Patients with arthritis may get relief from their condition using MaharasnadhiKwatha, a polyherbal formulation that has been shown to be safe and nontoxic. Parts of 26 distinct plants are utilized to make this concoction, which has a number of traditional medicinal uses including pain relief, inflammatory reduction, and antipyretic action.[12]

OBSERVATION & RESULT

Within two days, the patient's swelling and tenderness decreased. Within seven days, all symptoms showed signs of improvement. After a follow-up of 28 days, almost all symptoms had disappeared. Following our effective course of treatment, we monitored the patient every 15 days for the following three months. I discovered that there are no symptoms at all (with the exception of sporadic, mild knee discomfort, which is normal for the patient's age and the chronic illness) (Tables 7–12).

CONCLUSION

Ayurveda has its own, time-tested theories for treating all diseases, known as Chikitsa Siddhanta. Ayurvedic care of Aamvata is one of the most effective therapies because treatment for Aamvata has limitations in other pathies. This case study demonstrates how Ayurvedic medicine can provide patients with immediate comfort while also challenging societal norms on gradual healing.





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Table 1: Showing materials for Treatment of Aamvata as.

Sr. No	Dravya	Dose	Duration	Anupana	
1	Yogaraj Guggulu	1 gm	1 TDS	Luke warm water	
2	Vatagajankusha Rasa	250 mg	1 TDS	Luke warm water	
3	MaharasnadiKwath	50ml	Thrice in a day	Luke warm water	

Table 2: Showing PanchakarmaTreatment of Aamvata as.

Panchakarma		
Rooksha Swedana	ValukaPottlisweda	
Snehana	Himalya pain relief oil	
Lepanam	Pidaharlepa	
Virechana	Shunthi Siddha Eranda Tail (5 ml at morning)	

Table 3: Grading of Sandhishoola (pain).

Sr. no	Severity of Pain	Grade
1	No pain	0
2	Mild pain	1
3	Moderate, but no difficulty in moving	2
4	Much difficulty in moving the body parts	3





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Table 4: Grading of Sandhishotha (swelling).

Sr.no	Severity of swelling	Grade
1	No swelling	0
2	Slight swelling	1
3	Moderate swelling	2
4	Severe swelling.	3

Table 5: Grading of Sparshasahatwa (tenderness).

Sr.no	Severity of Tenderness	
1	No tenderness	0
2	Subjective experience of tenderness	1
3	Wincing of face on pressure.	2
4	Wincing of face and withdrawal of the affected part on pressure	3

Table 6: Showing Samprapti Ghatak.

Sanprapti Ghatak			
Dosha	Vata Sheet, Ruksha, Chala - Guna Vrudł		
Dosna	Kapha Sheet, Guru - Guna Vrudhi.		
Dushya	Rasa, Rakta.		
Adhishtana	Sandhi		

Table 7: Assessment of Sandhi-Shool.

Left		Name of Joint	Right	
Before	After		Before	After
3	0	Parva sandhi	3	1
2	0	Janu sandhi	3	1
3	0	Manibandha	3	0
1	0	Ansa sandhi	1	0
1	0	Kurpara sandhi	1	0

Table 8: Assessment of Sandhi-Shotha.

Left		Name of Joint	Right	
Before	After		Before	After
2	0	Janu sandhi	3	1
3	0	Manibandha	3	0

Table 9: Assessment of SparshaAsahatwa (tenderness).

Left		Name of Joint	Right	
Before	After		Before	After
2	0	Manibandha	3	0

Table 10: Assessment of Angamarda (malaise).

Angamarda(malaise)		
Before	After	
3	0	





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Table 11: Assessment of Aruchi (anorexia).

Aruchi(anorexia)		
Before	After	
2	0	

Table 12: Assessment of Morning stiffness.

Morning stiffness		
Before	After	
3	0	





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RESEARCH ARTICLE

Effectiveness of Positional Release Technique Versus Active Release Technique along with Conventional Physical Therapy in Subjects with Lateral Epicondylitis – A Comparative Study

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ABSTRACT

The most common myotendinitis of the forearm is lateral epicondylitis, which affects the extensor muscle tendons' common attachments in the lateral epicondyle and impairs the afflicted limb's ability to function normally. The objective of this study was to compare the efficacy between Active Release Technique and PRT along with conventional physical therapy on subjects with LE. The study recruited 30 patients with chronic LE of age group 30 to 50 years out of which 4 subjects dropped out. By using the chit technique, patients were divided into two groups at random: group A (ART n=13) and group B (PRT n=13). The intervention period was 2 weeks alternate days and two outcome measures: the PRTEE questionnaire for pain and function and the Pressure algometer for PPT score were taken for assessment and analysis on the first day and the last day. The PRTEE score and pressure algometer value of PPT in all of the targeted muscles significantly changed between the pre-and post-intervention in the ART group and PRT group. The independent t-test found no statistically significant difference in the variance of PRTEE and pressure algometer value post-intervention between the ART and PRT groups. ART and PRT may be beneficial for the treatment of LE along with conventional physical therapy.

Keywords: Lateral epicondylitis (LE), Active Release Technique (ART), Positional Release Technique (PRT), PRTEE, Pressure Algometer, Pain Pressure Threshold (PPT).





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INTRODUCTION

Lateral Epicondylitis(LE) is known to be the most common myotendinitis of the forearm affecting the common attachments of the tendons of the extensor muscles in the LE impeding the normal function of the affected limb [1]. In 1873, Runge was the first to describe LE as a chronic symptomatic degeneration of the humeral epicondylar attachment of the common extensor tendon in the forearm. 1 to 3 percent of middle-aged individuals without regard to gender are affected by LE in the general population². Although the actual cause of LE is unknown, it is most likely caused by recurrent microtrauma by very tight gripping, excessive wrist extension, radial deviation, or forearm supination [2]. Nirschl (1992) describes the primary structure involved in LE as the tendon of the ECRB and extensor commmunis tendon in one-third of cases [3]. Patients typically report pain or a burning sensation around the LE of the humerus, along with weakness in their grip and lifting abilities. The severity frequently varies from mild to severe and also from intermittent to persistent, which has an impact on the patient's quality of daily life [1,4,5]. In a subject with lateral epicondylitis, the myofascial pain goes unrecognized or misdiagnosed. Myofascial trigger points in the triceps and forearm extensor muscles have been shown by David Simons & Janet Travell to be the exclusive source of discomfort associated with tennis elbow and lateral epicondylitis [6,7]. The trigger points that are most prevalent in tennis elbow are brachioradialis, extensor carpi radialis, biceps brachii, supinator, and triceps brachii⁶. Once these trigger points are palpated and confirmed, they can be treated with MFR and ultrasound or other therapeutic interventions for the reduction of pain [8,9]. Anti-inflammatory medicines, ultrasound, iontoporosis, or phonoporosis are used as part of the LE treatment program, which is subsequently followed by stretches and resistance training to increase flexibility and endurance, rest, ice, counterforce bracing, acupuncture, and ergonomic modifications or training [10,11]. Emerging studies of manual therapy along with conventional interventions like ultrasound and low laser therapyhave exhibited greater results in improving pain and dysfunction associated with chronic LE [11,12]. ART has been used successfully to treat numerous musculoskeletal problems, LE is one of them, according to a small but rising body of literature [13]. Therefore, this study's aim was to compare 2 soft tissue techniques namely ART (Active Release Technique) with PRT (Positional Release Technique) along with conventional physical therapy with Patient Rated Tennis Elbow Evaluation and Pressure Algometer as an outcome measure.ART combines exact patient movement with site-specific physical pressure[14].During ART, the patient voluntarily moves the tissue through the adhesion site from a shorter to an extended position as the physician administers deep digital tension to the sensitive region[15]. A passive intervention called PRT or SCS (Strain Counterstrain Technique) is used to treat musculoskeletal pain and dysfunction that goes along with it (Ambrogio, 1997)[16]. The goal of all PRT techniques is to gently hold tissues in an 'eased' or comfortable state until a positive shift or release naturally takes place [17].

MATERIALS AND METHODS

The primary data of this study was collected from Kamrup Metropolitan City. A total of 30 subjects were recruited according to convenient sampling out of which 4 were excluded and 26 more subjects were split into 2 groups: Group A (n=13) ART and Group B (n=13) PRT.

Study design - Experimental study

Inclusion Criteria

Subjects aged between 30-50 years of both genders with a complaint of pain at the lateral epicondyle for 3 months duration with positive Cozen's and Mill's test.

Exclusion Criteria

Subjects having upper limb fracture, skin infections or diseases, open wounds on or around the forearm and complaints of pain for less than 3 months.





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Materials

Pen and paper Pressure Algometer PRTEE questionnaire Chair and sitting stool Pillow Couch Informed consent form

PROCEDURE

Active Release Technique (ART) along with conventional physical therapy(GroupA)

Each subject was in a position in accordance with the muscle being treated. The trigger point was palpated over the targeted area (ECRB, brachioradialis, and triceps) and tension was applied in a sustained mode combined with a specific patient's active hand movement with 15 repetitions. Ultrasound was applied with a frequency of 3MHz and an intensity of 1.5 W/cm² in a continuous mode for the duration of 8 minutes. Static stretching was given passively to the targeted muscles with a holding time of 30 seconds each for 3 sets of repetition.

Positional Release Technique (PRT) along with conventional physical therapy(Group-B)

The patient was in a position in accordance with the muscle being treated, and the affected limb was palpated for the trigger point over the targeted muscles and pressure was applied in a sustained mode with the limb brought into a position of comfort. The manual pressure and the position were maintained for about 90 sec with three repetitions for each targeted muscle. Ultrasound was applied with a frequency of 3MHz and an intensity of 1.5 W/cm² in a continuous mode for the duration of 8 minutes. Passive static stretching was given to the targeted muscles with a holding time of 30 seconds each for 3 sets of repetition.

STATISTICAL ANALYSIS

Version 27 of the SPSS (Statistical Package of Social Sciences) was utilized to analyze the current research. An independent sample t-test was utilized to evaluate the shift in outcome measure scores "between the two groups. The statistical significance was determined at a significance level of 0.05.

RESULTS

In Table 1 (PRTEE scores), a p-value <0.001 indicates that the scores decreased significantly after intervention for both study groups. In comparison, a p-value of 0.980 indicates that the decrease in PRTEE score is not significantly different. A Cohen's d value of -0.010 implies that the mean difference in the decrease of PRTEE score Post-intervention between Group A and Group B is very small, approximately 0.010 times the pooled standard deviation. This suggests that the two groups have very similar outcomes in terms of the change in PRTEE score after the intervention. In Table 2 (pressure algometer values), a p-value <0.001 indicates that the scores increased significantly after intervention for both study groups. In comparison, Cohen's d value of 0.015 in ECRB, 0.009 in brachioradialis, and 0.003 in triceps implies that the mean difference in the decreased scores Post-intervention between Group A and Group B is very small. A p-value of 0.97 indicates that the increase in the scores of each muscleis not significantly different in both groups.

DISCUSSION

This research showed that a particular manual therapy treatment plan focused on the release of TrPs was effective in treating LE patients. Success was assessed using a variety of objective and subjective metrics, including pain and





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function surveys and objective tests of pain threshold. Subjects with lateral epicondylitis were split into two groups in this research to assess the efficacy of two different treatment methods i.e., ART n=13 and PRT n=13 with PRTEE and pressure algometer as an outcome measure. The analysis result showed a significant difference between pre and post-test PRTEE score and pressure algometer value of PPT in both the groups. However, comparatively, there was no significant difference between the two groups. To determine the pre and post-intervention PRTEE scores, a paired sample t-test was conducted separately for both the study groups indicating significantly decreased scores (p <0.001) post-intervention for both the study groups. Consistent results were attained in the former studies by Parth Trivedi et al., (2015), KM Harneet (2021), and Priyanka Dakbara et al. (2022)[10,18,19]. ART removes adhesions restores normal tissue texture and improves the pain and functional status (Scott D Howitt, 2006)[14]. The significant improvement of PRTEE score in group B [PRT n=13] can be supported by a study done to address tendinopathy at the elbow by Baker and colleagues (2014) where they found a major improvement in range of motion, pain, and functional status with patient satisfaction after PRT intervention [20]. Similarly, Wong and colleagues (2011) showed a significant increase in elbow strength in a healthy group after tender point treatment [21].PRT influences proprioceptive activity, aids in restoring normal muscle tone and length-tension relationships, and lengthens the affected muscle fiber to its normal condition, which reduces discomfort and improves functional status [22]. With the readings obtained from the pressure algometer for PPT, a paired t-test of p-value <0.001 denotes a significant difference between pre- and postintervention in both groups. Jun Ho Kim et al. (2015) obtained a conclusion in their study where the values of pre-and post were significantly different after receiving ART [23]. When ART had been utilized to treat subjects with adductor strain, Robb et al. observed that the patients' muscle PPT immediately improved [24].

After ART intervention on the gluteus medius of a patient with low back pain, Tak et al. obtained improvement in the VAS score of the patient and PPT [25]. After the removal of scar tissue that is adhered to soft tissue, there may be an improvement in PPT due to a reduction in muscle tone (Jun Ho Kim et al. 2015). Likewise, the obtained PPT values on group B of the current research are supported by a study done by M. Mohammadi Kojidi et al. where they have procured an increase in PPT value significantly post-treatment of TrPs by PRT [26]. It also supports the findings "of Meseguer et al., who discovered that PRT was successful in lowering discomfort indicated by a rise in pressure pain thresholds of trigger sites in the upper trapezius muscle of patients with mechanical neck pain [27]. Hutchinson's findings, which suggested that the SCS method may be effective in treating tender spots around the elbow in patients with a history of an upper extremity recreational sports injury, provide significant support for the present findings [28]. Based on past and recent discoveries, it seems that PRT approaches have the ability to give quick alleviation of local pain and tenderness induced by MTrPs. The administration of PRT is believed to diminish tissue tenderness by modifying nociceptor activity in the soft" tissues [29]. Hence, it is concluded that both methods are efficient in the reduction of pain with an increase in PPT while improving the functional status of the subjects.

CONCLUSION

As there wasn't much of a difference between the two groups, this research came to the conclusion that both treatment methods, when used in conjunction with traditional physical therapy, may help patients with lateral epicondylitis reduce discomfort, improve function, and raise their pain threshold.

Limitations & Future Recommendations

The study sample size was small with no control group. The treatment technique was limited to only three muscles. There was no follow-up done. Further studies can be conducted with a larger population adding a control group and taking another group of muscles into consideration in addition to the muscles targeted in this study along with a follow-up.

Conflict of Interest: No conflict of interest.





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Table 1: PRTEE score comparison between group A&B

	Group A	Group B				
Pre-intervention	53.0 ±12.4	52.9±13.3				
Post-intervention	13.3±2.6	13.2±3.0				
p-value	12.655(<0.001)	12.338(<0.001)				
Comparison between the groups						
	39.7 ±11.3	39.8±11.6				
P – value	0.026 (0.980)	0.026 (0.980)				

Table 2: Pressure algometer score between groups A&B

	Group A			Group B			
	ECRB	BR	Triceps	ECRB	BR	Triceps	
Pre	1.088±0.204	0.951±0.149	1.695±0.318	1.092±0.204	0.956±0.154	1.695±0.318	
Post	2.057±0.330	1.444±0.154	2.502±0. 157	2.057±0.318	1.444±0. 153	2.503±0.156	
t-test (p-value)	12.818 (<0.001)	9.351 (<0.001)	8.631 (<0.001)	11.294 (<0.001)	9.048 (<0.001)	8.470 (<0.001)	
	<u> </u>	Co	omparison bet	ween the grou	ps		
	Group A	Group B	T-test (P_val	ue)	Со	hen's d"	
ECRB	.969±.273	.965±.308	0.037		0.015		
BR	.490±.185	.488±.194	1.00		0.009		
Triceps	.807±.337	.808±.344	0.007		0.003		





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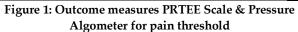




Figure 2: Positional Release Technique & Active Release Technique





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RESEARCH ARTICLE

Android Bluetooth Device Control for Industrial Automation

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ABSTRACT

The paper presents the home appliances like a lightweight, Using an Android smart phone and a wireless microcontroller, you can control your TV and fans. Utilising cell technology, which benefits our society, makes it feasible. The goal of this project is to help the physically challenged and elderly people. Automated processes provide comfort for operator and increase productivity. The risk involved is also decreased with the advent of remote systems, it is now feasible to access and operate the strategy, system, or interface from a computer or mobile Android device with a user-friendly interface. A strategy must be developed using mobile electronics and control concepts. In the recent times, The efficiency and capabilities of mobile devices have greatly increased. This project helps to develop device control for industrial automation.

Keywords: Android, Bluetooth, device control, industrial automation





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INTRODUCTION

The objective of using Arduino for Wireless Device Control with Bluetooth is to enhance the working capabilities of the devices that are under control. The planning is an eco-friendly one[1]. This method saves space for recycling. Storage is a major problem and takes lot of space. The transportation cost is very high. Aluminium is used to make beverage cans. These aluminium modules are often recycled into similar products with better quality, efficiency and reliability. The need for Wireless technology is ever increasing and hardware is practically feasible.

Proposed System

The main goal of this project is to develop a system that supports industrial devices and the elderly. The objective of this project is to take into consideration all the domestic systems that are difficult to control by elderly people and the handicapped. The project will enable anyone with a Bluetooth-enabled device to Android mobile phone to get an application from the Google Play Store. With the help of this application, user can control all the appliances in the house via Bluetooth receivers [2]. The proposed system allows the clients to have access to all the appliances in the house including air conditioners, and lights, with a single click on a mobile phone to turn it either ON or OFF. Most important consideration in the application is that it must be simple to use friendly and simple to operate. By opening the application, the user can also check the status of the appliances to see whether they are ON or OFF. The application's GUI needs to be given top importance if we're going to create a user-friendly application and achieve all of our project's goals. The interface of the application will prove how simple it is to use the application as well as give flexibility to the user. The following list of objectives must be fulfilled to successfully help elderly and disabled individuals.

- 1. Develop Bluetooth appliance controller: The Bluetooth will interface with the microcontroller to perform the desired automation. The Bluetooth-enabled mobile phone will send signals to the microcontroller, which will process them.
- 2. Develop an application for a mobile phone: An application needs to be developed for the mobile phone, which needs to communicate with the Bluetooth receiver HC 06.
- 3. Integrate the device to the controller: The cost-effectiveness of a Smart Home must be the top consideration when designing it. The appliance controller has to be inexpensively integrated with the appliances in the house with an easy installation.
- 4. Test the set up and analyze the data: After the system is configured, with the help of a mobile device and a controller, tests are conducted while data is recorded and analyzed.

Hardware

The hardware components are shown below.

Software Components

The software consists of a toolbar which is used interfacing. The toolbar is shown in Fig 3. The working of the software is shown in the example given below.

Project Analysis

A BlueGiga WT11 Bluetooth component is used with an Arduino BT, an 8-bit microcontroller board. This module offers the functionality required for Bluetooth wireless serial connection. This board has I/O ports, A/D converter, PWM and other extra resources help it be beneficial for the required work. For testing purpose, 25W, 240V lamps are used. The device alerts the user if there is a malfunction and says that the execution was unsuccessful.





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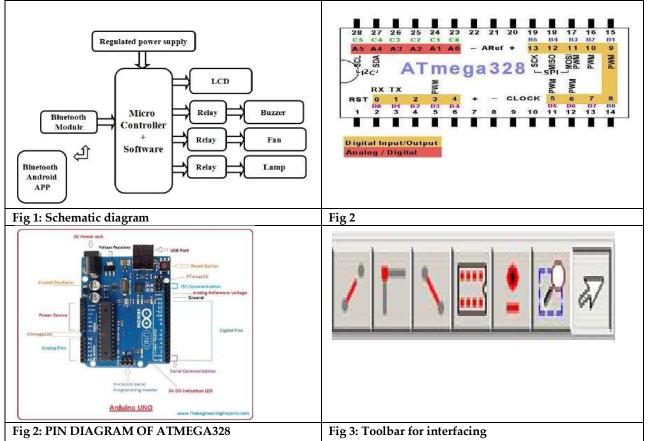
CONCLUSION

The system was designed in such a way that any electrical home appliance can be operated through webpage. The controlling of electrical appliances is done through Wi-Fi. Hence, "Bluetooth Based device Automation" integrates features of all the hardware components used. Advanced micro controller is employed in it. Multiple electronic devices are controlled and standing of these devices may be monitored through Bluetooth. The Arduino microcontroller has been developed to control a number of home automation gadgets in response to commands from the user. The system's capacity to communicate through Bluetooth has been coded in. The technology is demonstrated to make it easier to control devices that are used in homes.

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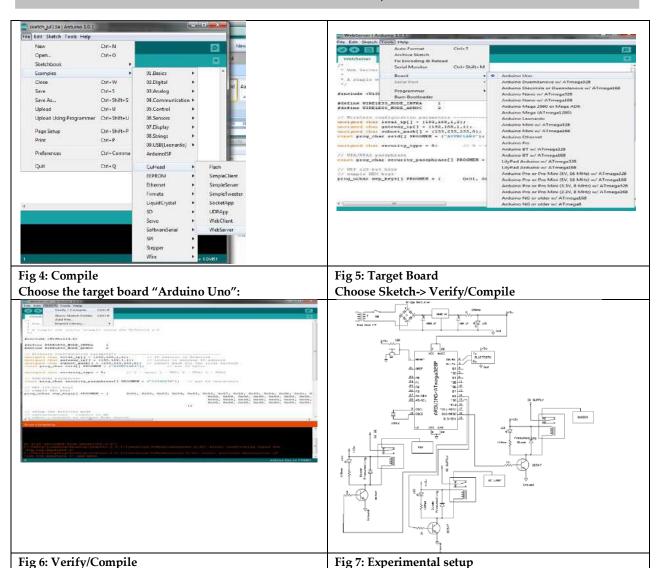
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RESEARCH ARTICLE

A Contribution of Bi-Regular in Bi Near-Ring

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ABSTRACT

In our study, we have presented foundational concepts regarding binear-rings (BNR). Additionally, we have provided illustrative examples and delved into theorems associated with these concepts. Moreover, we have investigated the relationship between bi-regular and P-bi-regularity, where P represents various types of ideals utilized in these concepts. To support our endings, we have included numerous examples, propositions, and theorems. Finally, we have offered explanations for the results obtained in this study, elucidating them through various examples.

Keywords: Near ring(NR), Bi-near ring(BNR), Zero Symmetric, Bi-regular(BR), P-bi regular, Weakly bi regular.

INTRODUCTION

An algebraic structure known as a near-ring (NR) is defined by a binary operation that adheres to all ring axioms except, potentially, one of the distributive laws and the commutativity of addition. The origins of this concept can be traced back to the seminal work of Dickson in 1905. Similarly, a bi near-ring (BNR) shares similarities with NR but imposes fewer axioms. While NR naturally emerge from functions on groups, BNR constitutes a distinct branch of algebra that has been extensively studied. For a comprehensive understanding, one may consult [1]. Motivated by the exploration of bi ideals in [6] and influenced by the investigation of BNR presented in Bi-algebraic structures and Smarandache bi-algebraic Structures, American Research Press, 2003 by [12], we introduce the innovative concept of weak bi ideal in BNR.





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PRELIMINARIES

Definition Let $(\varphi, +, \cdot)$ bean on-empty set. The nφ is BNR if it can be expressed as $\varphi = \varphi_1 \cup \varphi_2$, where φ_1 and φ_2 are proper subsets of φ such that $\varphi_1 \varphi_2$ or $\varphi_2 \varphi_1$. Furthermore, Bis considered a BNR if at least one of $(\varphi_i, +, \cdot)$ is RNR satisfying the following conditions

- 1. $(\varphi_1,+,\cdot)$ is a NR
- 2. $(\varphi_2,+,\cdot)$ is a ring.

Moreover, even if both(ϕ_i ,+,·)are RNR,(ϕ ,+,·)is still considered a BNR. It is important to note that by default, when we refer to a BNR, we mean specifically a right BNR.

Example Let take Z is a NR and Z_{10} is a ring. Then φ = $Z \cup Z_{10}$ is a BNR.

Definition In a BNR $\phi_0=\{n\in\phi_1\cup\phi_2/b0=0\}$ is zero-symmetric part, then ϕ is termed zero-symmetric, if $\phi=\phi_0$, (i.e) $\phi_1=\phi_{10}$ and $\phi_2=\phi_{20}$.

Definition ABNR of φ is bi P-regular BNR if for every element of a BNR is regular. (i.e) For any $\alpha \in \varphi_1 \cup \varphi_2$ there exist $\beta \in \varphi_1 \cup \varphi_2$ and P be any ideal of φ then $\alpha \beta \alpha + p = \alpha$.

Example Take z is a NR and Z_{12} is a ring. Then $\phi = Z \cup Z_{12}$ is a BNR, and if take $P = \{Z \neq \phi\}$. Then it is a P-bi regular in BNR.

Definition 2.6 A bi subgroup B_1 of a BNR of(φ ,+) is weak bi ideal, if $B^3 \subseteq B_1$.

Definition 2.7 In a BNR, is strongly bi-regular, if $\alpha = \beta \alpha^2$, where $\alpha \in \varphi_1 \cup \varphi_2$ and $\beta \in \varphi_1 \cup \varphi_2$.

Remark 2.8 Every bi-ideal of BNR is indeed a weak bi-ideal of a BNR. However, the converse is not necessarily true.

Theorem 2.9 A homomorphic image of P-bi regular is also P-bi regular.

Proof: Let $f:\varphi \to \varphi$ *be a homomorphism where $\varphi = \varphi_1 \cup \varphi_2$ and $\varphi^* = \varphi_1 * \cup \varphi_2 *$. Given P be a weak bi ideal of bi regular in $\varphi = \varphi_1 \cup \varphi_2$.

Hence $\alpha = \alpha \beta \alpha + p = \alpha \beta \alpha + \varphi_1$.

 $Now, \alpha\beta\alpha + \varphi^3 \subseteq \alpha + \varphi_1 \subseteq \varphi = \varphi_1 \cup \varphi_2 \subseteq \varphi$

Let $\alpha' + \varphi' = f(\alpha) + f(\varphi_1)$. Then take $\beta' \in f(\varphi_1)$.

Now, $\alpha' + (\beta_1')^3 = f(\alpha) + f(\beta_1)^3 \subseteq f(\alpha) + f(\varphi_1) = \alpha' + \varphi'$

(i.e) $(\alpha' + \varphi_1'^3) \subseteq \alpha + \varphi_1$

Hence $\varphi = \varphi_1 \cup \varphi_2$.

Theorem 2.10 Intersection of weakly bi ideal is also a weakly bi ideal of BNR.

Proof: Let V be a weakly bi ideal of BNR, $\varphi = \varphi_1 \cup \varphi_2$. Then $V^3 \subseteq V$. Similarly W be a weakly bi ideal of φ , if $W^3 \subseteq W$. Now intersection of two weakly bi ideal is $(V \cap W)^3 \subseteq V^3 \cap W^3 \subseteq V \cap W$ Similarly $V \cap W \subseteq (V \cap W)^3 \subseteq V^3 \cap W^3$. Hence $\varphi = \varphi_1 \cup \varphi_2$.

Theorem 2.11 A Zero symmetric BNR is bi regular if fit is a BR. **Proof:** Proof of the theorem is trivial.





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Theorem 2.11 A Zero symmetric BNR is strongly bi regular. Then φ is a BR.

Proof: Let $\varphi = \varphi_1 \cup \varphi_2$ be a BNR. We know that Let φ be a strongly bi regular BNR of φ , if $a \in \varphi_1 \cup \varphi_2$ there exists $b \in \varphi_1 \cup \varphi_2$ such that $\beta = \alpha \beta^2$. By Zero-symmetric property,

```
\beta-(\alpha\beta^2)=0
\beta(\beta - b\beta^2) = \beta 0
\beta \alpha \beta (\beta - \alpha \beta^2) = \beta \alpha \beta 0
We have to prove that \beta^2 = \beta^3
(\beta - \alpha \beta^2)^2 = (\beta - \alpha \beta^2) (\beta - \alpha \beta^2)
=\beta(\beta-\alpha\beta^2)-\alpha\beta^2(\beta-\alpha\beta^2)
=\beta 0-\beta \alpha \beta 0
=(\beta 0-\beta \alpha)\beta 0.
Now we get
(\beta - \alpha \beta^2)^3 = (\beta - b\beta^2) (\beta - b\beta^2)^2
=(\beta-\alpha\beta^2)(\beta 0-\beta\alpha)\beta 0
=(\beta-\alpha\beta^2)(\beta-\alpha\beta^2)
=(\beta-\alpha\beta^2)^2.
Therefore
(\beta - \alpha \beta^2)^2 = (\beta - \alpha \beta^2)^3
Consequently
=(\beta-\alpha\beta^2)\beta=(\beta-\alpha\beta^2)^2\beta=(\beta0-\beta\alpha\beta0)\beta0\beta=(\beta-\alpha\beta^2)^2=(\beta-\alpha\beta^2).
Hence \beta = \alpha \beta^2. Therefore it is bi regular of BNR.
```

CONCLUSION

In this paper, we have developed the notion of bi-regularity innear-rings (BNR), driven by the exploration of BNR as documented in [7]. The introduction of the concept of 'weak bi-ideal' in BNR in 2003 [12] served as a foundational motivation for our research. Our investigation extends to proving zero-symmetric properties utilizing the concept of bi-regularity in BNR. Additionally, we have established the notion of P-bi-regularity in BNR, where Pre presents any ideals. Furthermore, we delve into homo morphic concepts within the context of our research.

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RESEARCH ARTICLE

Optimizing Crop Recommendations: Machine Learning for Comparative Approach

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ABSTRACT

Crop recommendation systems powered by machine learning algorithms have become indispensable tools for modern agriculture, facilitating informed decision-making and enhancing productivity. This study presents a comparative analysis of machine learning-based approaches for optimizing crop recommendations. By leveraging diverse datasets encompassing soil characteristics, climate conditions, and historical crop performance, various machine learning algorithms are evaluated for their efficacy in predicting suitable crops for specific agricultural environments. Through a systematic comparison of these methods, including decision trees, support vector machines, neural networks, and ensemble techniques, we assess their performance, scalability, and applicability in real-world scenarios. The findings offer valuable insights into the strengths and limitations of different machine learning approaches, aiding stakeholders in making informed choices for crop selection and resource allocation. This comparative approach provides a roadmap for advancing crop recommendation systems, thereby contributing to sustainable agriculture and food security.

Keywords: Crop prediction, Random Forest, Decision trees, Gradient boosting, Machine Learning, Data Analytics.





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INTRODUCTION

The Indian economy's foundation and most important industry is agriculture. India's vast population of 1.5 billion+ people is fed thanks to the agriculture industry, which occupies more than 60% of its land. Agriculture, which has been vital to India's emergence as a civilisation, is based on the cultivation of animals and plants. Because it gives plant roots necessary nutrients, oxygen, water, and structural support, the soil is crucial to agriculture [1]. It is the foundation of the entire food system and is essential to ensuring high-quality food production. Alluvial soil, black soil, red soil, and laterite soil are just a few of the numerous soil types found in India, each of which is ideal for growing a certain crop [2]. Alluvial soil is best for growing cotton and rice, black soil is best for growing sugarcane and sunflowers, red soil is best for growing maize and ragi, and laterite soil is best for growing pulses, tea, and coffee, among other crops. To improve agricultural planning, which uses machine learning approaches for crop recommendation, many research investigations have been carried out. Machine learning, a feature of artificial intelligence [6], enables machines to imitate intelligent human behavior. Artificial intelligence (AI) systems use techniques similar to those used by humans to do complex jobs, but with the added benefit of automation. Data, which can take many different forms including financial transactions, personal information, or even photographs, is where machine learning processes begin. In order to use machine learning into agricultural planning, relevant data must first be gathered and processed as training data for the system [7]. It is generally acknowledged that more data volume can lead to better results. A suitable machine learning model is then chosen, and the information gathered is utilized to train the system to recognize patterns and independently produce predictions.

REVIEW OF LITERATURE

The advancement of artificial intelligence has created new prospects for agricultural framework advancement [1]-[8]. The most extensively used machine learning approach for agricultural yield prediction [9], [10], and agriculture planning. Several authors have published articles on the effectiveness of machine learning algorithms for crop yield prediction. The authors of a study published in May looked into applying machine learning algorithms to help farmers make intelligent crop selection decisions based on geographic and environmental parameters. To achieve its goals, the research study used many algorithms, including decision trees, KNNs, Random Forests, and neural networks. Across all three studies, the neural network consistently displayed the best level of precision. Some of the articles about crop yield prediction in India have been summarized here. Many factors influence agricultural production, including climate conditions, rainfall, temperature, soil information such as pH and soil type, crop information, nutrients, disinfectants, water quality, and so on.[2]-[5]. Accurate forecast of crop yield history is vital information that can be utilized to make agricultural risk management decisions. Before cultivating on the field, the farmer will check the crop yield. This offers farmers an idea of what will happen to a specific crop that year. If the conditions are favorable, this could help them increase crop productivity. It may also assist them in reducing loss owing to improper conditions. Most academics are currently employing machine learning methods to predict and validate the issues in precision agriculture[6]-[11]. Machine learning is an important step toward a bright future in agriculture. There are numerous technologies available that minimize risk, increase sustainability, and put the producer at the center of predictively informed decisions. All of these technologies rely heavily on machine learning. A farmer can log onto a customized dashboard on a computer or tablet and see all the data connected to his crop and problems linked to crops and yield, as well as effective methods for dealing with the problem, using Machine Learning. Machine Learning provides the grower with information on his or her own enterprise, changing the way they view farming. The author [12] focused on crop yield prediction using a data mining technique, specifically a random forest classifier for both classification and regression tasks. Their efforts resulted in the creation of a userfriendly website that uses climate data to anticipate agricultural production for a specific crop. The random forest method predicted crop yield with an outstanding 95% accuracy rate.





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PROPOSED SYSTEM

Based on specific soil factors, the proposed approach will suggest the most suitable crop for cultivation.

Data Collection

Data collection is a widely used and effective approach for obtaining and evaluating information from various sources. To provide the system with a comprehensive dataset that enables accurate crop recommendations, the following characteristics should be included and considered:

Soil

Information about the soil type, composition, and properties is essential as different crops thrive in different soil conditions.

pН

The pH level of the soil is crucial as it affects nutrient availability and overall crop growth.

Temperature and Humidity: These environmental factors play a significant role in determining the suitability of crops for specific regions or seasons.

NPK Levels

The levels of nitrogen (N), phosphorus (P), and potassium (K) in the soil impact plant nutrition and crop productivity. Monitoring these levels is essential for effective crop recommendations.

Crop Information

Data related to specific crop characteristics, such as growth cycle, water requirements, disease susceptibility, and vield potential, help in understanding crop suitability and making appropriate recommendations.

Data Pre-Processing

There are several methods involved in data pre-processing, starting from reading the collected dataset and progressing to data cleansing. During this process, certain dataset properties that are irrelevant or redundant for crop recommendation are excluded. Additionally, datasets that contain missing data need to be handled appropriately. The missing values can be either removed or replaced with specific undesirable values, such as "nan," to ensure higher accuracy in the subsequent analysis and modeling stages. By effectively pre-processing the data, we can ensure that it is in a suitable format for training the model and generating accurate crop recommendations.

Feature Engineering

Feature engineering is a process that involves creating new features or transforming existing ones from raw data using domain knowledge. The objective of feature engineering is to enhance the quality and effectiveness of machine learning outputs by incorporating additional relevant features.

Training set

The training set is a specific type of dataset that contains labeled data, where both input vectors and corresponding output values are available. In supervised machine learning, the training set is used to train the model using various techniques. By utilizing the labeled data in the training set, the model learns patterns and relationships between input features and output values, allowing it to make predictions or classifications on unseen data.

Testing set

A testing set, also known as a validation set or a holdout set, is a dataset that does not contain any labeled or tagged information. It is used to evaluate the performance of a trained machine learning model and assess its predictive capabilities on unseen data.





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The testing set is distinct from the training set and is kept separate to ensure that the model's performance is not biased or overfitted to the training data. Once the model has been trained on the labeled data from the training set, it is then applied to the testing set to make predictions or classifications based on the learned patterns and relationships. By evaluating the model's performance on the testing set, we can assess its generalization ability and determine how well it performs on new, unseen data. This evaluation helps to validate the effectiveness and reliability of the trained model before deploying it in real-world scenarios.

Machine Learning Algorithms

Machine learning prediction methods need for exceedingly precise estimation based on prior knowledge. Data, statistical techniques, and machine learning strategies are used in predictive analytics past knowledge to predict future outcomes. Beyond merely comprehending what occurred, the objective is to offer the greatest solution possible and a forecast of what will happen next. The methods utilised in this model are Logistic regression, Naive Bayes, Random Forest, Decision Tree and Gradient Boosting.

Logistic Regression

The logistic model in statistics is a statistical model that depicts the likelihood that an event will occur by making the event's log-odds a linear combination of one or more independent variables. In regression analysis, logistic regression is used to estimate a logistic model's parameters.

Here, the link function g(), the target variable E(y), and the linear predictor (to be forecasted) are all present. The purpose of the link function is to 'connect' the linear predictor to the expectation of y.

Naive Bayes

The Bayes theorem was used to construct Naive Bayes, a simple and uncomplicated probabilistic classifier. The value of one feature, given the class variable, is assumed to be independent of the value of any other feature by Naive Bayes classifiers.

$$P(A | B) = (P(B | A) * P(A)) / P(B)$$
(2)

Decision Trees

In supervised learning, Decision Trees (DT) are used for classification and regression. The problem is handled using a tree representation, with each leaf node representing a class label. and each node inside the tree represents a characteristic.

Entropy

Random Forest

To solve classification, regression, and other issues, a huge number of unique models are generated using the ensemble learning approach known as Random Forest. Throughout the training process, decision trees are used. The random forest method generates decision trees from a large number of data samples, predicts data from each subset, and votes on it to deliver a better response to the system. RF uses the bagging strategy for data training, which improves the accuracy of the results..Formula:

Gini Index =1-
$$\sum$$
 (Pi) 2 i = 1 = 1 - [(P+) 2 + (P-) 2](4) Support Vector Machines :





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The SVM method's purpose is to determine the best line or decision boundary that can divide n-dimensional space into classes, allowing us to classify fresh data points quickly in the future. This ideal decision boundary is known as a hyperplane.

SVM chooses the extreme vectors and points that will help create the hyperplane. The SVM approach is built on support vectors, which are utilised to represent these extreme cases. Here, we employ linear SVM.

The hyperplane equation used to classify the points is as follows:

H:wT(x)+b=0(5)

Extreme Gradient Boosting

Gradient Boosting is supervised ML method for dealing with classification and regression issues. It's a mediocre ensemble prediction model. The same as with earlier boosting strategies, an incremental gradient-boosted trees model is built.

Crop Recommendation

The crop recommendation model utilizes soil characteristics such as NPK levels, temperature, humidity, and pH to suggest the most suitable crop for cultivation. By analysing these factors, the model provides recommendations that align with the specific requirements and preferences of the given soil conditions. This helps farmers make informed decisions about crop selection, maximizing their chances of achieving higher yields and profitability.

Performance Analysis

Performance analysis is a specialized discipline that focuses on improving productivity and decision-making through a systematic approach. It involves evaluating various aspects of a system, process, or activity to identify strengths, weaknesses, and areas for improvement. In the context of agriculture, performance analysis can involve assessing the efficiency and effectiveness of farming practices, crop management strategies, resource allocation, and decision-making frameworks.

RESULT ANALYSIS

The proposed model makes use of soil parameters and a crop database. The ideal crop for the specific soil is suggested by machine learning algorithms. Gradient boosting was the method we tried with the most accuracy. The accuracy ratings for each algorithm are listed below.

CONCLUSION

In conclusion, this study has explored the potential of machine learning algorithms in optimizing crop recommendations for agricultural settings. Through a comparative analysis of various machine learning techniques, including decision trees, support vector machines, neural networks, and ensemble methods, we have evaluated their effectiveness in predicting suitable crops based on soil characteristics, climate data, and historical performance metrics. Our findings demonstrate that machine learning-based crop recommendation systems offer promising opportunities for enhancing agricultural productivity and sustainability. While each machine learning algorithm has its strengths and limitations, our comparative approach provides valuable insights into their performance and applicability in diverse agricultural contexts. Decision trees excel in interpretability and ease of use, making them suitable for straightforward recommendation tasks. Support vector machines offer robust classification capabilities, particularly in scenarios with complex data patterns. Neural networks exhibit exceptional learning capabilities and can capture intricate relationships between input variables and crop outcomes. Ensemble methods combine the strengths of multiple algorithms, resulting in improved prediction accuracy and generalization. By utilizing crop recommendation systems, farmers can make informed decisions about which crops to grow, maximizing their productivity and profitability. These systems consider a range of data, including historical crop performance, soil analysis, weather patterns, and market trends, to provide personalized recommendations tailored to the unique





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characteristics of each farm. The ultimate goal of implementing such systems is to empower farmers, enabling them to make well-informed choices that result in higher crop yields, reduced risks, improved resource utilization, and ultimately, increased income. By leveraging the benefits of agricultural research and technology, these crop recommendation systems aim to contribute to the overall growth and prosperity of the agricultural sector while improving the livelihoods of farmers across India.

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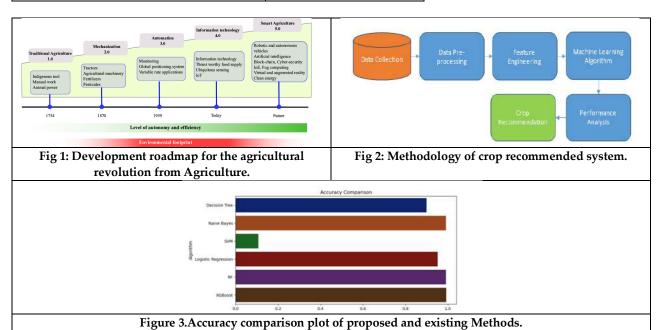




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Table 1. Accuracy of the Algorithms

Algorithms	Accuracy		
Logistic Regression	97.12		
Decision Tree	95.51		
Naïve Bayes	96.08		
Random Forest	98.56		
SVM	94.54		
Extreme Gradient Boosting	98.25		







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RESEARCH ARTICLE

Survey on Entropy based Defense Mechanisms against DDOS Attacks in SDN-Cloud Environments with Pox Controller

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ABSTRACT

Detecting and mitigating Distributed Denial of Service (DDoS) attacks is the job of entropy-based security systems, which use metrics of network traffic's randomness and unpredictability. These techniques are able to detect and filter out harmful traffic by comparing the entropy of incoming packets to determine if a pattern is typical or unusual. With the POX controller, entropy-based defenses implemented in Software-Defined Networking (SDN)-Cloud settings to make them more resistant to distributed denial of service (DDoS) attacks, which are always changing. In this review article, we look at how well entropybased defensive mechanisms function in SDN-Cloud settings using the POX controller to prevent Distributed Denial of Service (DDoS) attacks. Distributed denial of service (DDoS) attacks continues to be a major concern for network infrastructures, impacting both services and operations in a disruptive way. One potential way to make SDN-Cloud systems more resistant to these kinds of attacks is to use entropybased approaches. This article reviews 40 research papers for DDoS Attacks detection and explores the potential of computer-assisted methods for DDoS Attacks and staging. This review compiles previous studies that have looked at different entropy-based protection tactics, how they work, and how they are used in SDN-Cloud systems to counter DDoS attacks. In order to help academics and practitioners better protect SDN-Cloud infrastructures against distributed denial of service (DDoS) attacks, this study also covers problems, unanswered questions, and potential future developments in the field.





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Keywords: Cloud environments, Distributed Denial of Service, Entropy-based defense mechanisms, POX controller

INTRODUCTION

Software-Defined Networking (SDN) in the cloud is vulnerable to Distributed Denial of Service (DDoS) attacks, which can compromise the availability and dependability of network services. The goal of these attacks is to make the targeted systems unusable by flooding them with malicious traffic. Due to their complex and ever-changing nature, traditional security methods often fail to adequately counteract DDoSattacks [1-7]. To make SDN-Cloud infrastructures more resistant to DDoS attacks, entropy-based security techniques have been a good option in recent years. When analyzing the properties of network traffic, entropy—a measure of randomness and unpredictability—is an important statistic to consider [8-15]. It is feasible to distinguish between typical traffic patterns and abnormalities caused by DDoS by examining the entropy of incoming packets. This knowledge allows entropy-based security systems to identify and counteract distributed denial of service (DDoS) attacks as they happen; reducing the damage they do to network operations [16-18]. Protecting SDN-Cloud settings against DDoSattacks using entropy-based protection methods and the POX controller is the goal of this survey article. From [19-24], we explore many facets of these defensive systems, such as their theory, methods of implementation, and efficacy in reducing DDoS attacks. The review highlights important developments, obstacles, and prospects in the field of entropy-based DDoS prevention in SDN-Cloud systems by combining previous research results and approaches [25-27]. This survey provides academics and practitioners with a great opportunity to learn about the latest methods for entropy-based DDoSattack defenses in SDN-Cloud systems. In order to further fortify the security of SDN-Cloud infrastructures against ever-changing DDoS attacks, we also want to draw attention to possible future research and development paths [28-30].

LITERATURE SURVEY

Survey on entropy-based defense mechanisms against DDoS attacks

Agrawal et al. (2021)the author make out how to protect ourselves against shrew attacks by combining SDN with cloud computing. Defense against such attacks was made simpler with SDN's unique capabilities, such as centralized management, dynamic forwarding rules updates, and global network visibility. The shrew attack detected, mitigated, and traced back using the approach proposed in this paper. Attacks identified by observing changes in packet size and entropy at the source IP addresses. The Access Control List(ACL) and Software Defined Networking(SDN) flow-table were used to limit the impact of the attack after it was recognized. By using the record route options field of the IP packet header, the Deterministic Packet Marking(DPM)trace back technique was able to ascertain the actual location of the attack flows. Under both attack and non-attack conditions, the SDN-based cloud platform's performance was assessed. Al-Gboury HA et al. (2020) An extensive analysis of unmanned aerial vehicle(UAV) networks, their services, and their applications was highlighted in this report. In-depth analyses of the SDN paradigm, controllers, and Software-Defined Wireless Mesh Networks(SDWMN) have been published in the literature. When compared to other controllers, the Ryu controller performs better in terms of latency and packet loss, according to the simulation findings. Babbar, H., & Rani, S. (2021)The performance of the network, as measured by the SDN Controller Ryu, with respect to nine hosts and four switches, was the primary subject of this article. After the implementation was tested using many parameters, including Round-Trip Time (RTT) and bandwidth, results were produced. In order to gauge the Ryu controller's efficiency in a mininet with a tree topology, iperf was used to evaluate the Transmission Control Protocol/User Datagram Protocol(TCP/UDP) server or client on hosts h1 and h4. BN, Yuvaraju et al. (2020) In today's dispersed networking systems, SDN plays a crucial role. The communication system was also getting more difficult to secure using a distributed method. The current system only takes action after a distributed denial of service (DDoS) attack has begun; the suggested system, on the other hand, provides a proactive solution by detecting the attack's harmful behavior and preventing it from happening before the attack





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even begins. Channel capacity and buffer were the resources that will be exhausted during a distributed denial of service (DDoS) attack, and this was taken into account throughout the modeling process. Dutta, M. and Granjal, J., (2020) Smart cities, smart homes and buildings, intelligent transportation systems, and many more application fields were being transformed by the fast development and integration of IoT technologies with the physical world. Security at the device and network levels becomes vital when resource-constrained devices (things) were linked to the unreliable and untrustworthy Internet. As sensing and actuating devices were increasingly incorporated into the Internet communications architecture, intrusion detection, prevention, and response systems serve as a secondary line of defense, after cryptographic procedures, to ensure security. Ganesan, N. et al. (2020) In the context of future 5G networks, pox controller was used to enable network slicing features. Network slicing was performed using the delay and packet loss functions. The centralized control was the most appealing aspect of using SDN. A predetermined state in an end-to-end environment was monitored via centralized control. The findings show that when bandwidth was differentiated, the packet loss rate was 7%. Gautam, Priya et al. (2020) In a typical networking design, the control and data planes were combined using networking devices that were difficult to deploy and manage. By eliminating the controlling mechanism from networking hardware, software-defined networking reduces it to a basic forwarding node. The controller that was logically centralized was responsible for these nodes. These authors research examines the performance of both conventional networks and software-defined networks allowed by Open Flow using the mininet network simulator. Using the ping command, the author checked for connection and compared network latency as part of these authors network connectivity test. Gautam, Y. et al. (2020) the author built a firewall application for security reasons by conducting two large-scale trials and analyzing the results to choose the best SDN controller. The author evaluated the POX controller's performance by blocking undesirable packets using the layer two firewall application in accordance with the policy file. However, there were a plethora of reference programs available for usage with Ryu controller.

SDN-Cloud Environments With Pox Controller

Hyder et al. (2021)A distributed environment using the Mininet emulator and Open Network Operating System(ONOS) SDN controller as a three-node cluster has been established to execute this framework. With the use of RestAPI and the ONOS application, developers have created Crossfire DDoS prevention that uses intent-based modifications to divert traffic via the combination of SDN, NFV, and IBN. The author opted for redirection since there's a possibility that malicious traffic can have entered the network disguised as normal if the author discard suspicious packets. Islam, M. T. et al. (2020) Using a single OpenFlow switch and three nodes, these authors research examines the RYU controller's performance assessment. The results of these authors comprehensive simulation analysis, which examined three distinct node-to-node paths using characteristics like as bandwidth, throughput, round-trip time, jitter, and packet loss, were shown below. Jia, Yizhen, et al (2020) The author started by outlining the two halves of FlowGuard's design—the Flow Filter and the Flow Handler. The Flow Filter was responsible for identifying unknown hostile flows based on differences in traffic and filtering malicious flows according to the filtration criteria set by the Flow Handler. Khalid et al. (2019) the author suggest building a defensive mechanism called QuSec-Nets to withstand adversarial attacks by taking advantage of trainable quantization's dynamic character and its insensitivity to tiny perturbations. Mishra, A. et al. (2021)The attackers initiate the DDoS attack to exhaust all the available resources of the targeted host, and the present techniques for protecting Open Storage Network (OSN) from DDoS threats were not producing adequate results. The author were defending against DDoS attacks by exploiting the SDN benefits in these authors paper. Every flow lead in the flow table has its counter verified according to its threshold, and the author have chosen three parameters-Match Field, Counters, and Actions-from the flow table parameters. An attack period was proclaimed if it above the threshold values; otherwise, it was considered a non-attack time. Ravi et al. (2020) These authors new security mechanism, L Earning-Driven detection Mitigation(LEDEM), was designed to protect MDAs that were deployed on IoT servers over wireless IoT. LEDEM offers two distinct approaches to fIoT and mIoT mitigation, as well as a semi supervised ML model for threat detection. These authors throughput was about 21% higher than that of state-of-the-art technologies. When the DDoS attack was generated, other measurements for network performance also showed improved values. To sum up, these authors security mechanism can protect users against Denial-of-Service attacks, even in the case that the Internet of Things server was targeted by wireless IoT devices. Roopak M et al. (2021) For the purpose of





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detecting zero-day DDoSattacks in IoT systems, this research presented an Intrusion Detection System (IDS) based on unsupervised learning. To evaluate the suggested model's efficacy, CIC-IDS2019 datasets have been used. The datasets' dimensionality was reduced from 88 to 25 using GRP, the feature selection approach used by the suggested model. For feature reduction, Gossip-Based Relay Protocol (GRP) was chosen over PCA and Autoencoder because to its computational efficiency, scalability, and noise resilience. The findings showed that using GRP improved the model's overall accuracy. To classify data instances as normal or attack, an ensemble model was used. Salam et al. (2021)There has never been a more talked-about and fascinating technological development than software-defined networks. It was critical to think about the difficulties since demand has increased. As the network expands, the controller's workload likewise rises, as shown in this study. As a result, the design of the single SDN controller was rendered inadequate. By examining the results of the evaluations, the workload was divided among the three controllers. To avoid the issues brought up by the hypothesis, it was clear that more than one controller was necessary. As latency grows, so does the packet drop ratio. Device instability was caused by the high packet loss ratio associated with the single controller design. Tufa, S et al. (2021)this study focuses on spotting and preventing distributed denial of service (DDoS) attacks that target software defined network systems in the cloud. There was a higher flow rule for attack flow hit counts in DDoS attacks compared to non-attack flow hit counts. Consequently, this method distinguishes between attack and non-attack flows by calculating the information distance. When DDoS attacks were detected, the system was protected by using the wildcard rule in conjunction with the removal of flow table switches. These switches prevent the sources of the attacks from making frequent requests. Several rounds of an adaptive boosting algorithm used to obtain learning data for predictive voting. Every iteration impacted by mistakes caused by little learning data. Iteratively processing massive amounts of learning data allows us to identify and remove this mistake.

EXISTING METHODS

Software Defined Networking

Software-Defined Networking (SDN) defensive techniques based on entropy take use of the unpredictability of network traffic to identify and counter Distributed Denial of Service (DDoS) attacks. These techniques examine incoming traffic to calculate entropy measurements and detect variations that indicate DDoS activity inside SDN designs, where network management is centralized and programmable. By implementing filtering rules or modifying Quality of Service settings, SDN controllers dynamically rearrange network devices in reaction to identified abnormalities, reducing the effect of attacks. A more secure and resilient network infrastructure is achieved via the use of entropy-based defensive mechanisms, which continually adjust detection thresholds and mitigation tactics in response to real-time data. This makes SDN installations more resistant to developing DDoSattacks.

Open Flow Protocol

With the OpenFlow Protocol in Software-Defined Networking (SDN) settings, entropy-based defensive methods against Distributed Denial of Service (DDoS) attacks take use of the protocol's programmability and centralized management. With OpenFlow, network flows dynamically modified, letting entropy-based defensive systems keep tabs on and assess traffic patterns in real-time. Entropy measurements are used to examine network traffic because they quantify the degree to which data flows are unpredictable and random. Possible denial-of-service (DDoS) attack activity is indicated by entropy levels that deviate from the norm. The effect of an attack reduced by the programmable reconfiguration of network devices by SDN controllers. These devices use mitigation measures including traffic filtering, rate restriction, or redirection. An improved defensive mechanism for SDN infrastructures against DDoSattacks is an entropy-based one, which makes use of the OpenFlow Protocol's programmability to react adaptively to new threats.

Large scale Software defined network

Implementing entropy-based defensive mechanisms in large-scale Software-Defined Networking (SDN) settings provides a proactive way to strengthen network security and resilience against Distributed Denial of Service (DDoS)





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attacks. Scalability and agility of defensive systems are of the utmost importance in these environments, as network infrastructures cover large geographical regions and service many users and devices. To identify and counteract distributed denial of service (DDoS) attacks, entropy-based defenses use metrics of network traffic's randomness and unpredictability. These techniques can categorize incoming packets as either normal or abnormal based on their entropy, allowing for the massive-scale detection and filtering of harmful traffic. Deploying entropy-based defenses across dispersed network components enables large-scale SDN systems to react in real-time to developing attack vectors and traffic patterns. These environments are characterized by centralized control and programmability.

About Ddos and Significance of Ddos

A Distributed Denial of Service attack is a malicious attempt to disrupt the normal traffic of a targeted server, service, or network by overwhelming it with a flood of internet traffic. Unlike traditional denial-of-service (DoS) attacks, which are launched from a single source, DDoS attacks employ multiple compromised computers and internetconnected devices, often spread across different geographic locations, to amplify the volume of traffic and make it more difficult to mitigate. The primary goal of a DDoS attack is to render the target inaccessible to its intended users, causing downtime, service disruptions, or even complete shutdowns. These attacks can be carried out using various techniques, such as flooding the target with massive amounts of bogus traffic, exploiting vulnerabilities in network protocols or applications, or consuming server resources through resource-intensive requests. DDoS attacks can have severe consequences, including financial losses, damage to reputation, and disruption of critical services. They are often employed by hackers, cybercriminals, or even politically motivated groups to achieve various objectives, such as extortion, revenge, activism, or sabotage. Mitigating DDoS attacks requires robust network infrastructure, proactive monitoring, and advanced security measures to detect and mitigate malicious traffic effectively. The significance of DDoS attacks lies in their ability to disrupt online services, leading to downtime, financial losses, and damage to reputation for businesses and organizations. These attacks not only hinder access to essential resources for legitimate users but also pose challenges to cybersecurity measures, requiring significant investments in infrastructure and personnel for effective mitigation. Beyond financial impact, DDoS attacks can tarnish brands, decrease customer trust, and even serve as diversionary tactics for more malicious activities. They also have social and political implications, being used at times for activism or protest, highlighting the need for robust cybersecurity strategies and collaboration between stakeholders to address the multifaceted challenges posed by these attacks.

DISCUSSION

The purpose of the survey paper's discussion part is to provide a thorough analysis and synthesis of the results given in the previous sections about entropy-based defensive mechanisms against DDoSattacks in SDN-Cloud systems using the POX controller. This section seeks to place the findings in the larger context of network security, highlight important ideas, talk about what this means for research and practice, and suggest some places where we can go from here in terms of further investigation. To begin, when talking about DDoS mitigation in SDN-Cloud systems, it's important to stress the efficacy of entropy-based defensive measures. Using entropy measures to differentiate between typical and unusual traffic patterns, these methods show promise in making network infrastructures more resistant to distributed denial of service attacks. To prove that entropy-based defenses work, the debate has to go into detail about particular case studies or experimental results that illustrate how well they detect and neutralize different kinds of DDoSattacks. In addition, the limits and difficulties of entropy-based protection mechanisms in SDN-Cloud settings should be included in the debate. Some of these factors to think about include computing expense, problems with scalability, the possibility of false positives, and evasive tactics used by malicious actors. To enhance the efficacy and dependability of entropy-based DDoS protection solutions, it is necessary to conduct more research and development in some areas; this conversation can shed light on these areas by recognizing these issues.





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CONCLUSION

In conclusion, this survey paper has highlighted the significance of entropy-based defense mechanisms in fortifying Software-Defined Networking (SDN)-Cloud environments against Distributed Denial of Service (DDoS) attacks. By leveraging measures of randomness and unpredictability within network traffic, entropy-based defenses demonstrate the capability to distinguish between normal and malicious traffic patterns, thus enabling effective identification and filtering of DDoS attacks. Implemented within the SDN framework with the POX controller, these mechanisms offer enhanced resilience by dynamically adapting to evolving attack vectors. Through a comprehensive synthesis of existing research efforts, this survey has underscored the efficacy of entropy-based defense strategies in mitigating DDoS threats and maintaining the integrity of SDN-Cloud infrastructures. However, challenges such as computational overhead, scalability concerns, and the evolving nature of DDoS attacks necessitate ongoing research and development efforts. By addressing these challenges and exploring future directions, researchers and practitioners can further strengthen the security posture of SDN-Cloud infrastructures, ultimately safeguarding against the disruptive effects of DDoS attacks and ensuring the continuity of network services and operations.

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Table 1: Comparison table for existing work with methodology

Author	Year	Method	Limitations	Advantages
Agrawal et al.	2021	Software defined networking	Due to their dependence on preset signatures or limits, existing techniques cannot be able to identify and neutralize developing low-rate DDoSattack tactics, like the Shrew attack.	Adapting network rules and configurations to changing threat landscapes and attack patterns is made easier using SDN-based techniques.
Babbar, H., & Rani, S.	2021	OpenFlow Protocol	When faced with massive networks including hundreds or even millions of devices, some software-defined networking (SDN) controllers can have performance issues or even bottlenecks.	With SDN controllers, network managers have never had it so easy to adapt network settings and rules on the fly to match fluctuating demands and traffic patterns.
Gautam, Y. et al.	2020	Packet Sniffing and Packet Spoofing	Security protections in software- defined networking (SDN) controllers might be difficult to implement for network managers without the necessary skills.	By consolidating network management functions into a single point, software-defined networking (SDN) controllers improve network security policy enforcement, analysis, and monitoring.
Rajoriya, M. K., & Prakash Gupta, C.	2021	Large scale Software defined network	Organizations lacking in knowledge or resources can find the deployment, setup, and administration aspects of implementing a distributed SDN controller architecture particularly challenging.	When it comes to managing massive network installations with varied needs and increasing traffic volumes, distributed SDN controllers are superior to single controllers due to their higher scalability.

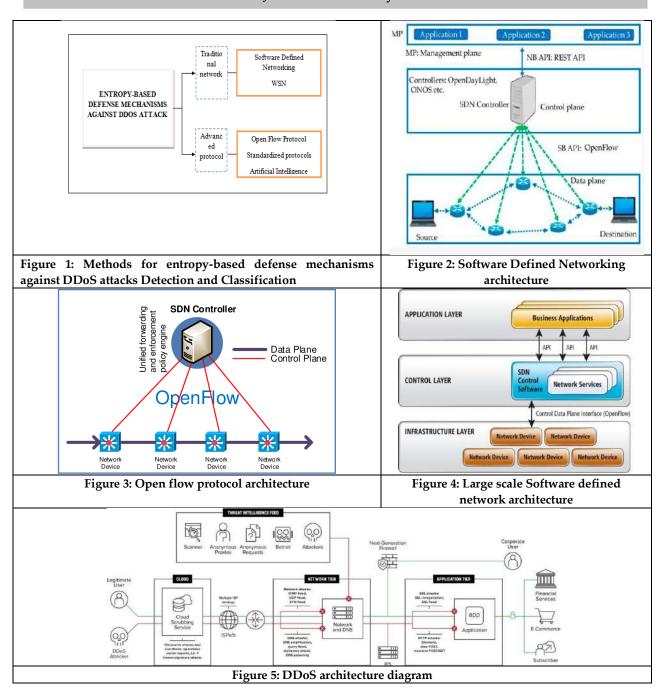
Table 2: Comparison table for existing methods

Aspect	Merits	Demerits
Software Defined Networking	Entropy-based defense mechanisms leverage measures of randomness and unpredictability in network traffic, leading to more accurate detection of DDoS attacks compared to traditional methods.	Implementing entropy-based defense mechanisms in SDN environments can require significant expertise in network security and data analytics, posing challenges for organizations with limited resources and specialized skills.
WSN	Entropy-based defense mechanisms can be implemented using lightweight algorithms suitable for resource-constrained WSN nodes, minimizing energy consumption and extending network lifetime.	WSN nodes typically have limited processing power and memory, which can constrain the complexity of entropy-based algorithms that can be deployed for DDoS detection and mitigation.
Open Flow Protocol	OpenFlow facilitates centralized management and control of network traffic flows, allowing for efficient deployment and coordination of entropy-based defense mechanisms across SDN infrastructures.	Centralized control introduced by OpenFlow can create a single point of failure, making SDN networks susceptible to attacks targeting the control plane, potentially compromising the effectiveness of entropy-based defense mechanisms.





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RESEARCH ARTICLE

Ethnomedication and Oncology: A Study on the use of Curcumin as a **Potential Herb for Cancer Treatment**

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ABSTRACT

In the present century, cancer is a significant health concern in the world. Cancer causes predominant deaths despite the drastic advancement in the health care facility, treatment and medicines worldwide. Apart from the dominant medicinal treatment, many new therapies emerged in the current age. Among them, plant-based treatment is emerging with new hope for the disease. The plant-based treatment is an ancient mode of cure and prevention for many ailments. This plant-based treatment can effectively reduce the incidents of cancer. Herbs can reduce the severity of cancer in several parts and organs of the human body. Ethnomedicine, so-called because of its origins among different ethnic communities, emerged as a counter to the western practices that study the bioactive compounds of plants and animals for the cure of human health. Ethnomedicines have played a vital role throughout human history in the day-to-day healthcare routine. Before the evolution of western medicine, for thousands of years, people have used this traditional medicinal system to treat different diseases. With cancer being the major threat to the human community, ethnomedicine can have a significant role in cancer prevention and cure. Thus, this paper tries to analyse some of the herbs as part of ethnomedicine and their effects on cancer.

Keywords: diseases, traditional medicine, healthcare, herbs, treatment





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INTRODUCTION

To understand the effectiveness of ethnomedicine on cancer, first, it is needed to study the cancer-causing genes. Cancer is a disease which affects cells of the human body. The affected cells grow uncontrollably and spread to other parts. The process of cell division is a controlled phenomenon that ensures that a healthy body's organs and tissues function properly. But in the case of cancer, when a cell divides quickly, it causes disastrous consequences. The process of cell division is termed DNA replication because a cell makes a copy of its DNA at the time of division. Moreover, hundreds of proteins are attached to this process. Therefore, uncontrolled division of cancer-affected cells can create any type of cell, harming organs, tissues, and the body. More precisely, there are four kinds of gene inculpate in cell division. The first one is oncogenes. This gene, in a usual scenario, instructs cells to necessitate division. Next, tumour suppressor genes act opposite to Oncogenes. The third gene is the suicide gene which is a complex phenomenon to understand. It involves many proteins. Usually, cells have a self-destructive capacity. Damaged cells have the ability to commit suicide, so the diseased cell will not be able to replicate. If the suicide genes are damaged, a diseased cell will replicate and gradually become cancerous. The fourth gene is the DNA-repair gene which allows DNA to repair the damage that occurred to it. But in any circumstance, if the DNA damage fails to repair, the damaged cells accumulate and cause cancer.

FACTORS RESPONSIBLE FOR CANCER

The damages mentioned above occurred due to an unhealthy lifestyle, consumption of tobacco, ethanol, low fibre food etc. Epstein-Barr-Virus (EBV), Hepatitis-B-Virus (HBV), and Human Papilloma Virus (HPV) are also cancercausing factors. Environmental exposure to UV radiation and the presence of other harmful chemicals like asbestos, chloride and benzene also causes cancer. Genetic factors also act as a catalyst for cancer-like diseases. Defective tumour suppressor genes and the mutated suicide genes act as a cancer-causing agents. The muted genes destroy the protein structure of the molecules and corrupt the cells. Therefore, the analyses of cancer-causing agents and cells reflect the disease's treatment, cure and prevention.

CANCER AND THE USE OF HERBS

Herbal medicines have been used for centuries to treat many malignant diseases. In popular culture, Phytochemical examination of herbs and plants helps indicate anti-cancerous properties. The article "Anticancer Therapeutic Potential of Soy Isoflavone, Genistein" marks that soybeans' phytochemical properties help prevent prostate cancercausing malignancies. Further, it mentions that a "daily intake of 40 grams of soybeans may significantly lower serum levels of prostate-specific antigen (PSA)" (153). Moreover, regular consumption of fruits and vegetables influences the human body with antioxidants and helps prevent cancer. Alireza Shabani, in "A review of Anticancer Properties of Herbal Medicines", states that "In Yemen, the local custom screening of native plants methanol extracted from some species including; Dendrosicyossocotrana, With aniaaduensis, With aniariebeckii, Dracenacinnabari (dragon's blood tree) used as anti-cancer compounds, and Buxus hildebrandlii showed cytotoxic effects on tumor cells" (2). Thus, ethnomedicine is an effective area to study in treating and preventing cancer. Contrary to synthetic drugs, the natural compounds of ethnomedicine are comprised of low to minimum side effects. The article "Medicinal Plants and Cancer Chemoprevention" analyses the effective plant-based medicine. It mentions the harmful impact of chemotherapy on the body and mentions

here are four classes of plant-derived anticancer agents in the market today, the vinca alkaloids (vinblastine, vincristine and vindesine), the epipodophyllotoxins (etoposide and teniposide), the taxanes (paclitaxel and docetaxel) and the camptothecin derivatives (camptothecin and irinotecan). (Desai et al.)

Plants contain a rich amount of natural chemoprotective potential properties to enhance anticancer therapy. Podophyllotoxin is most effective in treating lung cancer. It can be extracted from mayapple (Podophyllumpeltatum). The podophyllotoxin and other compounds from mayapple have the capacity to treat small cell and testicular lung cancer. Some other effective plants in preventing and treating cancer are the Mires plant (Tinospora cordifolia), wild





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jujube (Ziziphus nummularia), and the king of bitters (Andrographis paniculata) etc. The steam and roots of mires plant, leaves and roots of the king of bitters and flowers, seeds, roots bark and steams are used for medical purposes.

APPROACHES TO ETHNOMEDICINE

Ethno-medication is an herbal treatment that relies on plant-based medication. Thus, it has fewer side effects compared to the popular medication and chemotherapy for cancer. The harmful effects of chemo affect both the physical health and the psychological health of the cancer-affected patient. The medication using herbal and plant-based medication consists no such effect on the body. Moreover, the plant-based medication treats the affected cells and is a preventive measure for such disease. In contemporary times when environmental damage and an unhealthy lifestyle increase the risks of cancer, plant-based preventative medication ensures good health. Herbs like Curcumin, commonly known as turmeric, are prevalent in an Indian household and consist of properties which have the capacity to prevent and treat cancer. The mild nature of the herbs makes them, at the same time, safe and effective for treatment. Turmeric is most common in every household and is effective in cancer prevention and treatment. Curcuma longa, commonly known as *Haldi* in Hindi, comprises the active ingredient of Curcumin. Curcumin is derived from the rhizome of the turmeric plant. Turmeric restricts the proliferation of tumour cells. This anti-proliferation quality of turmeric regulates the cancer cells:

The anti-proliferative properties of Curcumin may be related to its ability to down-regulate the expression of a number of genes, including NF-kappa B, Activator Protein 1 (AP-1), Epidermal growth receptor 1 (EGR-1), cycloxygenase 2 (COX2), lysyl oxidase (LOX), nitric oxide synthase (NOS), matrix metallopeptidase 9 (MMP-9), and tumor necrosis factor (TNF). (Desai et al.)

Curcumin affects a polyphenol structure on growth factors of malignant cells. Its antimicrobial, antifungal, antioxidant, and anti-inflammatory properties affect defective tissues of the human body. Inflammation is considered one of the significant causes of cancer which also suggests the effectiveness of turmeric on cancer. Curcumin is a low toxin substance and can be regarded as chemo-preventive. Research reflects that,

Curcumin was shown to create a synergistic effect with the chemotherapeutic agent vinorel-bine, used for inhibiting the growth of squamous cell lung carcinoma H520 cells. Both agents lead to apoptosis by increasing the caspase-9 and caspase-3 activities and reducing the Bcl-2 and Bcl-X (L) expressions. (Unlu et al. 1051)

Turmeric is effective in invading tumour cells. Moreover, turmeric reduces the spread of cancer from one cell to another. It reduces MMP-2 activity by occupying HEp2 cell incursion. Curcumin is an anti-proliferating and apoptotic effect on the protein structure of cells. Curcumin rapidly decreases "mitochondrial membrane potential, release of cytochrome c, activation of caspases 3 and 9, and downregulation of anti-apoptotic proteins Bcl-XL and Inhibitor of Apoptosis Protein (IAP)" (Desai et al.). Thus, the effectiveness of Curcumin lies in its ability to deduce the growth of malignant cells. The tumour-associated and the genes associated with angiogenesis are affected by the Ethno-medication with Curcumin.

ETHNOMEDICINE AND IRULA TRIBES OF COIMBATORE

Traditional knowledge of the plants and herbs is widespread for the indigenous tribes at the Western Ghat, which is an integral part of their culture and history. Surrounding resources and the evolving interaction among the tribes and the herbs is the result of their medicinal knowledge. The Irulas tribe, a small community belonging to the Dravidian language family, constitutes only 26000 members in the southern state of Tamil Nadu. The tribe is notified as ST (Scheduled Tribe) by the Government of India and is one among the existing 36 sub-tribal communities in the state (Department of Tribal Welfare of Tamil Nadu, Statistic table, July 2006). The Western Ghat, where the tribe is located, is a rich resource of medicinal herbs and is famously known for its biodiversity. Like other tribes living in jungles and mountains, the Irulas depend heavily on medicinal plants for their well-being, and this knowledge is helpful for their own and for the livestock. The Anaikatti hills mainly surround the Irulas community near the Coimbatore district,





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where they stay in small hamlets. Ganesan and Kumaresen have studied the list of medicinal plants that this very community uses for different ailments. Among their list, the Curcumin has a notable presence. The community knowledge about Curcumin leads to various treatments besides cancer. Whether it is cardiovascular disease or gastrointestinal disorder, the use of Curcumin is frequent among them. They use the herb, both fresh and dried. For the preparation of medicine, fresh and dried serve as edible food and help remedy more than one ailment. Their innate ability and tremendous knowledge of the plant help meet the healthcare needs of the community people. Contrary to western practices, the ethnic knowledge of medicinal plants and herbs has opened the gateway for the research of cancer. The Irulas community serve as a potential bridging link for that.

CONCLUSION

While many approaches have been taken to invent drugs and find a cure for cancer with various means of technological up-gradation in medical sciences, ethnomedicine is a comparatively new approach to consider. The age-old medicinal knowledge of tribal and indigenous people from the remoter part of India is no new phenomenon since all the four branches of indigenous medicine; namely, Unani, Siddha, Ayurveda and Homeopathy, have its root in centuries of practice. With time and globalised knowledge patterns, all such practices are taking centre stage, and the exposure is quite a positive move. An ethnomedicinal approach is a counter approach to cancer-based research by looking into the potentials of traditional knowledge patterns of medicinal herbs and synthesising their utility in a research-oriented manner. Curcumin and its medicinal values are now widely known. What remains problematic is the less known value of this ethnic community, who have been using these plants and herbs for centuries, largely separating themselves from the general mass. It is high time to practice that knowledge and help find a crack into the health hazards like cancer.

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RESEARCH ARTICLE

A Quick Review on Application of TRNSYS to Renewable Energy **Systems**

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ABSTRACT

TRNSYS, an industry standard simulation tool, offers an effective platform for modeling and evaluating renewable energy sources as well as their application in various energy systems. The reliable and efficient simulation tool has been proven over time across a variety of systems around the world. Current work provides an introduction to modeling renewable and conventional transient energy systems using standard components/types as well as customized options/components/types. With the demand worldwide for green and sustainable energies has risen in recent years, the research effort to Integration of renewable energy systems have increased dramatically. This report consolidates the current knowledge of TRNSYS applications for renewable energy systems providing both professionals in their field as well as those new to the realm with an essential guide.

Keywords: TRNSYS, Renewable energy, HVAC and Refrigeration systems.

INTRODUCTION

TRNSYS is a transisent system simulation. As climate change becomes ever more critical and conventional energy sources becoming more scarce making the transition to green and sustainable energy sources has never been more essential. Renewable energy research is based on sophisticated simulation tools to aid in the creation, analysis and optimizing systems that harness renewable energy sources that are clean. Transient Systems Simulation (TRNSYS)





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stands out from the rest of these instruments as an encompassing and adaptable framework for modeling the fluctuating behavior of renewable energy technology. TRNSYS is a market-leading renewable energy program, supplies researchers, engineers and decision-makers with the tools they need for analyzing and simulating renewable energy technology under a variety of environments. Learning the way TRNSYS simulates and analyses the systems it models is crucial to making them more effective in their integration into actual life applications and handling intermittent energy source issues. Zarella et al conducted a test of validation for thermal P.V. Systems using TRNSYS [1]. Solar collectors that are hybrid were studied thoroughly. The effect of thermal capacitance from photovoltaic elements was considered for the solution of collector-related problems by using an electro-analogy methods. Studies comparing results obtained in various weather conditions with experimental data collected were also performed, including studying effects from collector thermal capacitances. Although variances were minimal, simulation test results more closely aligned with measurements taken. Kalogirou et al. [2] used TRNSYS analysis of a thermo-siphon flat plate collector with greater precision; their paper discussed Type 99 TRNSYS specifically. This type of energy analyzer is suitable for energy analysis of thermo siphons, flat-plate solar thermal Collectors and various commercial FPC machine layouts. Validity of Type 99 has been demonstrated through comparison between its results and those from an actual experiment. Antoniadis et al. [3] conducted research into thermal loads for building.

They considered solar panel domestic heat production in three separate weather zones for small residential water users and in concrete terms. Their research focused on understanding how an integrated solar thermal system with periodic storage functioned within a building by employing TRNSYS software. A system proposed here could cover approximately 67% of a building's heating requirements while simultaneously decreasing visual effects; at least 37% could also meet all 56 needs being covered by it. Due to increased heat requirements during winter and extended tank discharge, they determined it necessary to use an alternative source to meet load. Two recent examples demonstrate the success of EATEP by showing its broad applicability and versatility. With this model, two forms exist - the EATEP-EEP and EGP forms, respectively - to measure investments made by buyers of power generation systems of any size[4]. TRNSYS is a scalable environment to model a vast array of different systems like the solar system, geothermal and the building energy system. It supports both transient and steady state simulation.[5-6]. TRNSYS employs a model-based on components technique where different system components are represented as separate components that can be assemble to create a precise model of the whole system. TRNSYS is extensively used for simulation of solar energy sources like solar photovoltaic cells, wind turbines, thermal solar as well as biomass reactors for evaluating efficiency under different operational circumstances and parameters for input. TRNSYS lets researchers efficiently assess the efficacy in renewable sources of energy. Researchers utilize TRNSYS for analysis and simulate the efficiency of energy efficiency in buildings. It includes elements such as HVAC and insulation and occupancy patterns in order to model the patterns of consumption that alter within a building's entirety over the course of time. TRNSYS is widely employed in academic research contexts to analyze the efficiency of energy systems, optimising the parameters used in design as well as understanding the impact of these parameters on the efficiency of systems. The software is utilized to analyze the effect of the design parameters on efficiency[7-9].

TRNSYS is a global user community. It's a standard practice for members to work together to exchange models, data as well as knowledge via forums and conferences. The collaborative environment contributes to the constant improvement and advancement of TRNSYS. TRNSYS comes with an easy-to navigate user interface which allows researchers with a variety of degrees of experience to develop models quickly and clearly display the results, creating TRNSYS accessible to anyone. Researchers regularly validate and evaluate the validity of their TRNSYS model by comparing the outcomes of the simulation against those of benchmarks or experiments which have been set up[10-13]. TRNSYS ensures accuracy and reliability for simulation predictions by integrating with other simulation tools or optimization algorithms for enhanced capabilities and to meet specific research goals. Researchers utilize TRNSYS to gain an in-depth knowledge of complex energy systems, optimize designs, and assess impacts from various parameters. TRNSYS has proven invaluable as part of sustainable energy and building performance research[14-16]. Thermoelectric generators (TEGs) utilize See-Beck effects in semiconductors to convert heat energy instantly to electrical energy, leading to their immediate transformation to TRNSYS type TEGs which were introduced by Massaguar et al. as design tools. [17] The proposed segment can easily accommodate electrical and warm elements.





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According to its creators, TRNSYS recreation runs without interruptions or deferrals and therefore the mathematical model, as well as therefore this new segment, should be seen as very advanced. Abdunnabi et al.'s [18] experiment/simulation study on solar water heating systems confirmed their results as viable solutions. Results have demonstrated that TRNSYS simulation program offers pleasing forecast contrasts. Forecast and trial estimates in terms of daily energy collected from the framework were within 20%, while errors related to forecasting water source temperature fell within 16% Safa et al. [19] carried out a numerical simulation solar-assisted anaerobic digester reactor. Safa et al. [20] examined a ground source heat pump (GSHP) system consisting of horizontal ground circle pipe connected with TRNSYS that visualizes both house and heat pump, finding that its cooling COP value was relatively small while uncovering that distribution siphon did not feature variable speed operation; these factors being key reasons behind increased power utilization overall in their structure. Guarino et al. proposed an innovative TRNSYS environment which takes an LCA approach in terms of structure reproduction features during usage stage and life-cycle assessment approach. This device/type can investigate the impact of each step in the life-cycle process on energy usage in structures coordinated in TRNSYS climate environments and perform comprehensive LCA studies from support to support[21]. Compton et al. [22] conducted research at an energy plant located at University of Idaho Moscow Idaho USA which utilized TRNSYS modelling software.

Results have revealed that adding a turbine and expanding strain levels to their maximum potential level increases energy and exergy productivity by 3-4% and 5% respectively over current levels, according to six various contextual analyses conducted with TRNSYS display programming. Li and Jing [23] conducted an in-depth fuel utilization, energy effectiveness, and exergy proficiency analysis on each contextual analysis conducted using TRNSYS and CFD modeling of PV thermal system. CFD simulation was used to mimic a 3-dimensional CPV/T model from its inception to explore its impacts and identify optimal operating situations. Research revealed an ideal flow velocity to maximize thermal energy effectiveness for various solar cells under various concentration levels, but energy economy becomes costly when solar irradiance increases substantially. TRNSYS employs a component-based modeling approach. Users can construct complex energy systems by connecting individual components that represent devices or processes. Its modular structure enables greater customization in system design. Shrivastava et al [24] details this concept further presented their evaluation of TRNSYS simulation of solar water heating systems (SWH). Their report noted that SWH depended on factors like geological area, climate; working conditions; consistency and coherency of information as well as human errors - many of these being uncontrollable variables. Physical events such as spillage, scale arrangement failure and other physical anomalies often create shortcomings that are difficult to reenact. They reported that TRNSYS has undergone 12 significant updates and 35 years of constant development and advancement since first adopting it. Reenactment could be utilized effectively if all information gleaned through investigations were utilized accurately when formulating its product. Space heating using fossil fuels represents an integral portion of U.S. energy use. Terziottiet al. [25] provide further detail., through its study, demonstrated that 91% of energy for an enormous structure can be provided by an effective solar thermal energy storage (SSTES) system.

They explained seasonal solar thermal energy storage is an ideal way of providing heating to such structures when combined with an additional heat source such as an electric warmth siphon. TRNSYS boasts powerful capabilities while being user-friendly enough for model creation and simulation, making this energy system tool suitable for users at various levels of expertise in energy systems analysis. Solar collectors form the core components of solar thermal systems. Domestic applications typically call for low-cost and minimum maintenance flat plate collectors. Through research done using TRNSYS 18, an SHWS system was designed such that its outlet temperature nearly matches that required hot water temperature. Optimizations were carried out for parameters including collector monthly and hourly thermal efficiencies and beneficial energy gains; for Indian conditions the system's lifespan was evaluated[26]. Baglivo et.al. reported similar finding [27] researched the intensive energy usage in agricultural environments and assessed greenhouse thermal wellbeing and energy needs with an innovative dynamic simulation tool. Additionally, they compared different convective coefficient models until finding one with optimal characteristics - Ahamed et al. were one such study who conducted such an investigation. [28] conducted extensive work with solar greenhouses; they conducted comparisons of TRNSYS simulations against newly developed heating models such as CSHEAT to validate results and proved there is an average difference of 5.0% when modeling





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simulation models with TRNSYS; CSHEAT showed higher average differences when used. Bidhendiet al. presented these findings. [29] conducted an intensive analysis to simulate and validate TRANSYS type solar dish stilling engines for solar dish stilling purposes, using dynamic parameters in order to find numerical routines based on Schmidt's theory and identify values at various climate conditions (Karacavus et al. 2014). [30] investigated a system that produces hydrogen from water and stores it in a compressed tank before redirecting electrolyzed water towards P.V. panels for solar cells. To optimize production and storage as well as reuse of electrolyzed water for P.V. cells. Feng et al.[31] found that phase change units have significantly less of an impact on inlet flows with their conclusions including phase change units having significantly fewer impacts overall on inlet flows and lower overall costs associated with them. As our world becomes warmer, cooling needs increase steadily; desiccant cooling with solar assistance has an indispensable place in this field. Sudhakar et al. [32] recently utilized TRNSYS simulation software to model such an air-conditioning system for solar desiccant air-conditioning system. Hou et al. [33] used TRNSYS and MATLAB simulation models together, to bring efficiency improvements while aligning results from both systems. Hou's study included modeling-assisted by liquid dry cooler for predictive and integrated ground heat pumps integrated to TRNSYS for their research on this GSHP system with horizontally buried pipes.

Conclusion It can be concluded that HGSHP provides superior results when compared with conventional systems. Saleem et al. carried out a TRNSYS analysis of their hybrid solar-hydrogen generation system and conducted an optimization study to achieve maximum efficiency. Jonas et al. (2010) conducted this study using NIST standards to calculate chemical properties for 15 different working fluids. After careful investigation and examination, ammonia proved the optimal choice in both summer and winter conditions, offering peak energy gain nearing approximately 8000kJ/h with 120oC temperature rise (Jonas, et al. 2010). [35] performed TRNSYS analysis on PVT collectors to validate experimental results, employing a parametric identification approach in dynamic simulation to ascertain performance of PVT collectors. For their research project Brass et al. used TRNSYS analysis on two PVT collectors that operated within TRNSYS to gain performance insights; in their TRNSYS analysis for this research project they found two PVT collectors outperformed all others due to parametric identification techniques applied during dynamic simulation of performance characteristics of collectors. [36] investigated hot water load prediction for residential usage using Trnsys and DHW calculations to create realistic load profiles; parameters investigated revealed negligible heat loss across multi-house properties while consideration is also made of simultaneity factors. TRNSYS excels at transient simulation, enabling users to simulate dynamic behavior over time for systems they wish to model. This provides invaluable insights into how various components interact under changing conditions; providing insight into performance and efficiency for renewable energy systems.

Lamraniet al. [37] utilized Trnsys for their investigation of a hybrid solar wood dryer. Their main goal in using Trnsys was to find an appropriate numerical model which will assess indirect hybrid solar dryer performance, using Moroccan meteorological information as source data hour by hour dynamic simulations are being taken hour after hour from Trnsys for this research paper. Final output includes comparison between experimental and numerical conclusions which feature root mean square error of 0.24kg/kg and 3.9% relative error; an environmental-based analysis to quantify carbon dioxide emissions was then completed which yielded 34% emissions as shown below. Experiments were performed according to operating parameters that ensure thermal comfort of desired values are reached, with results showing significant humidity reduction at dehumidifier outlet [38]. Yasin et al. have also used TRNSys software to simulate chilled PCM ceilings for use as real building data inputs for their simulation model. This study presents a model that has been validated to meet phase change materials of chilled ceiling. Based on its validation results, type 399 PCM type chilled ceiling was chosen, where temperatures between +/-0.3 and +/-0.6 degrees are found and root mean square error is between 0.9KW-1KWKW. Ren et al. (2011) provide additional details. [40] conducted an in-depth research analysis utilizing both electricity and heat tracking modes to locate distributed energy systems using Trnsys, with similar environmental and economic outcomes regardless of which model was selected, although heat tracking showed greater efficiency compared with its counterpart. TRNSYS has long been recognized for its flexibility, offering support to a range of renewable energy technologies and building systems. Due to this flexibility, it makes a valuable resource for researchers working on diverse renewable energy projects involving double-diffusive convection and ventilation of buildings or spaces [41- 43]. The Energy





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Performance of Buildings Directive (EPBD) seeks to facilitate practical improvements of energy performance at reasonable costs in buildings through retrofit measures. The main goal is to demonstrate that various retrofitting solutions will prove successful over the long haul, without predefinitions and limitations that must be considered when arriving at an optimal solution. Climate is constantly shifting across many regions of the world and maintaining desired thermal comfort within buildings is absolutely critical to their proper operation[44]. Datta [45] explores how external influences may impact horizontal shading systems to measure building heating and cooling devices through TRNSYS simulation. As part of their effort, they selected cities like Milano, Roma, Napoli and Palermo in Italy where temperatures can range between moderately cold winter weather conditions and warm-hot summer conditions. These researchers reported that by employing appropriate shading equipment, 15 to 19 percent of size reduction for cooling is accomplished, which represents an impressive value given that cooling costs tend to be considerably greater than heating ones in terms of capital investment costs. Rosa et al. used TRNSYS sort, designed for short-term modeling, to implement a borehole-to-ground (B2G) model whereby BHE's complex efficiency could be represented at reduced computational costs and replicate the outlet; water temperature profiles provided an excellent comparison analysis between experimental measurements and B2G results.

Radiant panel systems are extremely energy efficient and achieve superior comfort levels when compared with HVAC systems; however, they lack in maintaining relative humidity indoors as they only transfer comfort levels. Eldeeb et al. [47] took an innovative approach to investigating this problem by developing and verifying a heat and moisture transfer panel (HAMP) through TRNSYS simulation software, then testing its effect on space relative humidity levels. Findings demonstrated HAMP's capacity for monitoring relative humidity across several cities near its location. HAMP was shown capable of maintaining relative humidity between 25% R.H. and 70% R.H. for dry weather conditions in Saskatoon, Phoenix and Chicago; 40-60% in Miami's humid weather condition; these energy effective units could potentially be utilized with RCP systems for any given climate condition in buildings throughout various climate conditions simultaneously. TRNSYS can be easily integrated with various software tools and allows users to blend the capabilities of advanced analysis software to provide a complete approach[48-49]. This approach of multidisciplinary research is what makes TRNSYS so useful. Ulleberg as well as Morner [50] examined the energy independence of buildings using solar hydrogen systems using TRNSYS.

Their research concluded that hydrogen may serve as a long-term, chemical energy storage, successfully simulating the model and validating it in a variety of climate conditions. TRNSYS is also equipped with technological economic analysis tools that allow users to evaluate the financial sustainability of renewable energy projects This feature is invaluable for stakeholders and decision makers seeking the most comprehensive understanding of cost of energy-related solutions as well as their impact. TRNSYS is equipped with an incredible library of components that represent key elements of energy systems. Solar collectors, heat exchangers motors, controls, pumps and more are only some of the components included in the energy system. The users are free to combine and modify these elements to create a precise representation of their own systems. This article functions as a must-read resource for practitioners, researchers and decision-makers looking for insights into TRNSYS applications for the context of renewable energy. In summarizing the important findings and laying out ways to further explore This article aids in the ongoing discussions about the use of the role of advanced simulation tools to constructing an energy future that is durable and robust. TRNSYS has a significant role in the advancement of renewable energy research because it provides an easy to make platform that allows for simulation and analysing the behavior of dynamic energy systems. Its intuitive interface, capabilities for transient simulation as well as the extensive library of components makes TRNSYS a popular choice for engineers and researchers who are focused on developing sustainable energy solutions.

CONCLUSIONS

TRNSYS (Transient Systems Simulation) is acknowledged as a powerful and flexible software that can be used to simulate and analysing renewable energy as well as the energy system for buildings. One of the primary platforms for modelling simulation, simulating and optimizing renewable energy technologies, TRNSYS gives users an





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extensive system for modeling solar PV panels, wind PV panels, geothermal panels; biomass cells as well as hydropower turbines to create comprehensive energy systems in a seamless manner. the user-friendly interface allows scientists and professionals in access to detailed performance analysis along with parametric studies and environmental impact studies of these systems.

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REVIEW ARTICLE

A Comprehensive Review of Dolomite Geochemistry and its Geological **Implications**

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ABSTRACT

This research article presents a comprehensive and contemporary review of dolomite geochemistry, exploring its intricate formation, distribution, and implications for geological processes. Dolomites, primarily composed of calcium magnesium carbonate, hold significant importance in geological and environmental studies. The review critically assesses current knowledge, delving into factors influencing dolomite genesis, diagenetic transformations, and their impact on reservoir quality. It examines classical and modern perspectives on dolomite formation, including primary precipitation, replacement processes, and the potential influence of microbial activity. The distribution of dolomites across diverse geological settings is emphasized as indicators of past environmental conditions. Additionally, the article highlights the role of dolomites in determining reservoir quality in hydrocarbon exploration, addressing challenges and controversies inherent in dolomite studies. Integrating cutting-edge geochemical analysis techniques, this review provides a valuable resource for researchers and scientists engaging with the captivating complexities of dolomite geochemistry.

Keywords: Dolomites, Geochemistry, Diagenesis, Sedimentary Rocks, Reservoir





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INTRODUCTION

Dolomites, composed primarily of calcium magnesium carbonate, stand as geological sentinels, bearing witness to the intricate processes shaping Earth's surface over geological epochs. The exploration of dolomite geochemistry has been a dynamic field of research, evolving through time to unravel the mysteries enshrouding these sedimentary rocks. As early as the 18th century, the enigmatic nature of dolomites caught the attention of pioneering geologists such as Déodat de Dolomieu, who first identified and characterized these distinctive carbonate rocks in the French Alps. Since then, a rich tapestry of literature has unfolded, weaving together observations, theories, and advancements in analytical techniques, contributing to our current understanding of dolomite geochemistry.

Historical Perspective

The historical journey into the world of dolomite geochemistry began with the pioneering work of Déodat de Dolomieu. In the late 18th century, Dolomieu's meticulous observations of the carbonate rocks in the Alps laid the foundation for the recognition and characterization of what would later be named "dolomite." His work, though not immediately embraced, marked the inception of an era where dolomites transitioned from geological curiosities to subjects of scientific inquiry. As the 19th century unfolded, the mystery surrounding dolomite deepened, prompting renowned geologists like Henry Clifton Sorby to delve into the mechanisms of dolomite formation. Sorby's microscopic studies revealed the intricate textures and fabrics of dolomites, paving the way for subsequent researchers to explore the microscale processes shaping these enigmatic rocks.

Evolution of Dolomite Geochemistry Research:

The 20th century witnessed a surge in dolomite research, marked by the development of advanced analytical techniques. Geochemists began employing stable isotope analysis, X-ray diffraction, and electron microscopy to decipher the geochemical intricacies of dolomites. The paradigm shift from macroscopic observations to microscale analyses expanded our understanding of dolomite formation mechanisms and diagenetic processes. The latter half of the 20th century saw the emergence of comprehensive reviews and seminal works consolidating the fragmented knowledge on dolomite geochemistry. Authors such as Robert L. Folk and Robert B. Dunham provided seminal insights into dolomite classification, emphasizing the need for a systematic approach to understanding the diversity within the dolomite family. The conceptual frameworks proposed by these researchers set the stage for subsequent investigations into dolomite distribution, formation, and alteration.

Contemporary Advances and Knowledge Gaps

In the 21st century, advancements in analytical techniques, such as high-resolution imaging and mass spectrometry, have further refined our understanding of dolomite geochemistry. Researchers have uncovered new aspects of dolomite diagenesis, unraveled the role of microbial activity, and explored the influence of environmental conditions on dolomite formation. Contemporary studies have also expanded the applications of dolomite geochemistry, particularly in the realm of hydrocarbon reservoirs and environmental science. Despite these strides, challenges and knowledge gaps persist. The complexities of dolomite geochemistry demand interdisciplinary collaboration and innovative approaches. The variability in dolomite compositions, textures, and associated minerals necessitates a nuanced understanding that transcends traditional disciplinary boundaries.

Purpose and Structure of the Review

Against this backdrop, this review aims to consolidate the wealth of knowledge amassed over centuries, offering a critical examination of the geochemical characteristics of dolomites. The subsequent sections delve into the mechanisms of dolomite formation, diagenetic processes, and the distribution of dolomites in different geological settings. The paper also explores the implications of dolomite geochemistry in hydrocarbon reservoirs, environmental contexts, and presents a thorough analysis of contemporary analytical techniques employed in dolomite research.





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Significance of the Review

Understanding the geochemical intricacies of dolomites is not merely an academic pursuit; it holds profound implications for diverse scientific disciplines. The insights gained from this review contribute to the refinement of geological models, aiding in the interpretation of ancient environments, and informing exploration strategies in hydrocarbon reservoirs. Additionally, the environmental implications of dolomite geochemistry have ramifications for water quality assessments and nutrient cycling studies.

Dolomite Formation Mechanisms

Dolomite, with its distinctive calcium magnesium carbonate composition, has long captivated the scientific community, yet the mechanisms underlying its formation continue to pose a geological enigma. This section delves into the intricacies of dolomite genesis, examining the primary mechanisms proposed to unlock the mystery of these enigmatic carbonate rocks.

Primary Dolomite Precipitation: The Geochemical Ballet

One of the prevailing theories suggests that dolomite forms directly from seawater through primary precipitation. This process entails the chemical conversion of magnesium-rich fluids into dolomite minerals under specific environmental conditions. The chemical ballet involves the interaction of calcium and magnesium ions in a supersaturated solution, leading to the nucleation and growth of dolomite crystals (Machel, 2004). However, the rarity of observable modern dolomite precipitation challenges the viability of this mechanism, leaving scholars to scrutinize alternative pathways.

Replacement Processes: Transformative Metamorphosis

An alternative mechanism posits that dolomite arises through the replacement of precursor calcium carbonate minerals, primarily calcite, by magnesium-rich fluids. This process, known as dolomitization, involves the substitution of calcium ions with magnesium ions in the crystal lattice of pre-existing carbonate minerals. Diagenetic fluids, enriched in magnesium, interact with calcium carbonate sediments, inducing a transformative metamorphosis (Hardie, 1987). Dolomitization often occurs in the subsurface, where geological pressures and temperatures facilitate mineral alterations. The intricacies of dolomitization remain a subject of ongoing research, with variations in the process attributed to factors such as fluid composition, temperature, and pressure (Mazzullo, 1998).

Microbial Influence: Nature's Dolomite Alchemists

In recent years, the role of microbial activity in dolomite formation has gained prominence. Microorganisms, particularly bacteria, may act as dolomite alchemists by influencing the geochemical conditions that favor dolomite precipitation. The microbial mediation hypothesis proposes that microorganisms produce metabolic by-products, such as organic acids, which promote dolomite nucleation and growth (Vasconcelos et al., 1995). This mechanism introduces a biological dimension to dolomite formation, adding complexity to the interplay between geochemistry and microbial processes. While microbial dolomite precipitation challenges traditional notions, its occurrence in modern environments and the identification of microbial biosignatures in ancient dolomites support the credibility of this mechanism.

Environmental Controls: Unraveling the Influence of External Factors

The formation of dolomite is intricately linked to environmental controls, including temperature, pressure, and fluid composition. Elevated temperatures and pressures, characteristic of deeper burial environments, are conducive to dolomitization reactions (Land, 1985). Moreover, variations in fluid composition, particularly the magnesium to calcium ratio, play a pivotal role in determining the propensity for dolomite precipitation or replacement processes. Understanding the environmental controls on dolomite formation provides a framework for interpreting the distribution and genesis of dolomites in diverse geological settings.





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Challenges and Controversies: Navigating the Dolomite Conundrum

Despite decades of research, the mechanisms driving dolomite formation remain subjects of debate and scrutiny. The challenges lie in the complex interplay of geochemical, biological, and environmental factors influencing dolomite genesis. The controversies surrounding primary precipitation, replacement processes, and microbial involvement underscore the need for interdisciplinary approaches to decipher the dolomite conundrum. As the scientific community continues to unravel the complexities of dolomite formation, advancements in analytical techniques and innovative experimental approaches offer promise in elucidating the enigmatic pathways that give rise to these captivating carbonate rocks.

Diagenetic Processes and Alteration of Dolomites:

Dolomites, as witnesses to the geological epochs, undergo diagenetic processes that shape their mineralogical and textural characteristics. This section delves into the transformative journey of dolomites, unraveling the diagenetic processes that mold these carbonate rocks over time.

Compaction: The Geological Sculptor

Compaction, a fundamental diagenetic process, imparts significant changes to the texture and porosity of dolomites. As sedimentary layers accumulate over time, the weight of overlying sediments exerts pressure on the underlying dolomite, leading to compaction. This process compresses the rock matrix, reducing pore spaces and altering the original fabric of the dolomite (Lloyd & Tucker, 1985). The compaction-induced changes contribute to the density and mechanical stability of dolomites, leaving behind imprints of the geological sculptor's hand.

Recrystallization: The Symphony of Mineral Transformation

Recrystallization, another transformative diagenetic process, involves the dissolution and reprecipitation of minerals within the dolomite matrix. Under the influence of pore fluids, particularly those enriched in magnesium, original dolomite crystals may dissolve partially, giving rise to a mosaic of newly-formed crystals (Mazzullo, 1998). This symphony of mineral transformation often results in the development of fine-grained dolomite textures, erasing the boundaries of pre-existing crystals and imparting a homogenous character to the rockThe extent and style of recrystallization depend on the composition of pore fluids, temperature, and the duration of diagenetic alteration (Hardie, 1987).

Dolomitization: The Chisel of Geochemical Change

Dolomitization, a diagenetic alteration process, remains a focal point in understanding the evolution of dolomites. As magnesium-rich fluids permeate through carbonate sediments, they initiate the replacement of pre-existing calcium carbonate minerals, commonly calcite, with dolomite (Hardie, 1987). This chisel of geochemical change not only modifies the mineralogical composition but also influences the porosity and permeability of dolomites, impacting their reservoir quality in geological formations. The mechanisms of dolomitization are diverse, ranging from fluid-rock interactions to microbial mediation, adding layers of complexity to the diagenetic evolution of dolomites (Machel, 2004; Vasconcelos et al., 1995).

Fluid-Rock Interactions: Geochemical Alchemy

Fluid-rock interactions play a pivotal role in dolomite diagenesis, influencing the mineralogical and chemical composition of the rocks. The chemical exchange between pore fluids and dolomite matrix results in alterations that reflect the geochemical alchemy occurring within the Earth's subsurface. The dissolution and precipitation of minerals, driven by variations in fluid composition, contribute to the diagenetic evolution of dolomites (Land, 1985). Understanding the geochemical intricacies of fluid-rock interactions provides insights into the pathways and mechanisms governing dolomite alteration.





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Pressure-Temperature Effects: Sculpting the Dolomite Canvas

The diagenetic evolution of dolomites is intricately linked to variations in pressure and temperature. Increasing burial depths subject dolomites to elevated pressures, inducing compaction and mineralogical changes. Moreover, variations in temperature influence the rate and style of diagenetic processes, sculpting the dolomite canvas with subtle nuances (Mazzullo, 1998). The interplay of pressure and temperature effects contributes to the diversity observed in dolomite textures and compositions across different geological settings.

Challenges and Unanswered Questions: Navigating the Diagenetic Labyrinth

While significant strides have been made in unraveling the diagenetic processes shaping dolomites, challenges and unanswered questions persist. The variability in diagenetic styles, the influence of microbial activity, and the role of external factors in modulating dolomite alteration present ongoing research opportunities. Navigating the diagenetic labyrinth requires interdisciplinary approaches, integrating geological, geochemical, and microbiological perspectives.

Dolomite Distribution and Geological Significance:

Dolomites, with their distinct calcium magnesium carbonate composition, exhibit a diverse distribution across various geological settings, leaving behind invaluable clues about Earth's dynamic history. This section explores the spatial and temporal distribution of dolomites, unraveling their geological significance as indicators of past environmental conditions.

Dolomite Distribution Patterns: Unraveling Geological Tales

Dolomites manifest in an array of geological settings, from ancient sedimentary basins to modern marine environments. Understanding the distribution patterns provides insights into the conditions favoring dolomite formation and preservation. In carbonate platforms, such as the Bahamas and Persian Gulf, dolomites commonly occur in shallow marine settings, reflecting the influence of evaporative conditions and magnesium-enriched pore waters (Pray & Wright, 1971). Additionally, dolomites are prevalent in ancient reefs, such as the Permian Capitan Reef in the Guadalupe Mountains, showcasing the affinity of these rocks for reefal environments (Smith & Banner, 1990). Sedimentary basins, especially those subjected to tectonic activity, host dolomites in deep burial settings. The Appalachian Basin and the Michigan Basin in North America provide examples of dolomites formed during subsurface diagenetic processes (Mazzullo, 1998).

Dolomites as Paleoenvironmental Indicators: Decoding Ancient Landscapes

Dolomites stand as silent storytellers of past environmental conditions, and their distribution can be a key to decoding ancient landscapes. The occurrence of dolomites in specific geological contexts provides information about parameters such as seawater chemistry, temperature, and the nature of microbial communities during dolomite formation (Hardie, 1987). The presence of dolomites in ancient marine sediments can indicate periods of seawater oversaturation with respect to dolomite, offering insights into the prevailing climatic and oceanographic conditions. Furthermore, the association of dolomites with certain types of organisms and sedimentary structures helps in reconstructing the ecological dynamics of ancient ecosystems. Dolomite distribution thus becomes a valuable tool for paleoenvironmental reconstruction, contributing to our understanding of Earth's past.

Dolomites in Hydrocarbon Reservoirs: Impact on Reservoir Quality

In the realm of hydrocarbon exploration and production, dolomites play a crucial role in determining reservoir quality. The distribution of dolomites within carbonate reservoirs significantly influences porosity and permeability, impacting the reservoir's ability to store and transmit fluids (Lüttge, 2001). The diagenetic alterations associated with dolomitization contribute to the creation of secondary porosity, enhancing the overall reservoir quality. Studies of dolomite distribution in hydrocarbon-bearing formations, such as the Permian Basin in West Texas, underscore the importance of considering dolomitization processes in reservoir characterization (Mazzullo, 1998). The recognition of





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dolomite-rich intervals in subsurface formations guides exploration strategies and reservoir management, demonstrating the practical significance of dolomite distribution in the energy industry.

Challenges in Dolomite Distribution Studies: Integrating Multidisciplinary Approaches

While dolomite distribution studies have provided invaluable insights, challenges persist in unraveling the complexities of their occurrence. The multifaceted nature of dolomitization, coupled with variations in depositional environments and diagenetic histories, necessitates an interdisciplinary approach. Integration of geological, geochemical, and paleontological methods is essential to enhance the accuracy of dolomite distribution interpretations.

Geochemical Analysis Techniques

The geochemical analysis of dolomites involves a suite of advanced techniques that unravel the molecular intricacies of these carbonate rocks. This section explores the methodologies employed to decipher the geochemical signatures embedded within dolomites, shedding light on their formation, alteration, and environmental implications.

Stable Isotope Analysis: Tracing the Isotopic Fingerprints

Stable isotope analysis stands as a cornerstone in unraveling the geochemical signatures of dolomites. Carbon and oxygen isotopes, in particular, provide essential information about the conditions under which dolomites formed. δ 18O and δ 13C values in dolomites can offer insights into paleo temperatures, fluid compositions, and the nature of diagenetic processes (Hudson, 1977). Isotope fractionation during dolomite precipitation or replacement processes leaves behind isotopic fingerprints that geochemists use to trace the history of these enigmatic rocks.

Elemental Composition Studies: Unlocking the Geochemical Palette

Geochemists delve into the elemental composition of dolomites to unravel the geochemical palette inherent in these carbonate rocks. Major and trace element analyses provide information about the source of dolomitizing fluids, the influence of external processes, and the variations in dolomite compositions across different geological settings (Land, 1985). Techniques such as X-ray fluorescence (XRF) and inductively coupled plasma mass spectrometry (ICP-MS) enable researchers to quantify and characterize the elemental makeup of dolomites with high precision.

High-Resolution Imaging Techniques: Peering into Dolomite Microcosms

The application of high-resolution imaging techniques, such as scanning electron microscopy (SEM) and transmission electron microscopy (TEM), enables researchers to peer into the microcosms of dolomite crystals. Microscale features, including crystal morphologies, textures, and any evidence of microbial structures, can be scrutinized at unprecedented levels of detail (Mazzullo, 1998). The use of these techniques enhances our understanding of dolomite diagenesis and aids in deciphering the mechanisms governing dolomite alteration.

Isotope Geochemistry of Fluid Inclusions: Trapped Chronicles of Dolomite Formation

Fluid inclusions within dolomite crystals encapsulate a wealth of information about the conditions prevailing during dolomite formation. Isotope geochemistry of fluid inclusions involves extracting and analyzing the fluids trapped within dolomite crystals. Stable isotopes and trace elements within these fluid inclusions serve as temporal markers, preserving a chronicle of the environmental conditions at the time of dolomite precipitation or alteration (Goldstein & Reynolds, 1994). This technique provides valuable insights into the evolution of pore fluids, the timing of dolomite-forming processes, and the potential influence of microbial activity.

Advanced Spectroscopic Techniques: Probing Molecular Bonds

Advanced spectroscopic techniques, including Fourier-transform infrared spectroscopy (FTIR) and Raman spectroscopy, play a crucial role in probing the molecular bonds within dolomites. These techniques provide information about the mineralogical composition, crystal structures, and subtle variations in the molecular





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environment of dolomite crystals (Lloyd & Tucker, 1985). FTIR, for instance, can identify specific carbonate phases and discern between different types of dolomites, offering valuable clues about their genesis.

Challenges and Emerging Frontiers in Dolomite Geochemistry

While these geochemical analysis techniques have significantly advanced our understanding of dolomites, challenges persist. The heterogeneity of dolomite compositions, the influence of secondary processes, and the potential overprinting of geochemical signals pose challenges in interpreting the data. Integrating multiple techniques and refining analytical protocols are essential steps to overcome these challenges and enhance the reliability of dolomite geochemical studies. Emerging frontiers include the application of novel analytical methods, such as synchrotron-based techniques and advanced imaging technologies, which offer unprecedented resolution and the ability to explore previously inaccessible microenvironments within dolomites. Additionally, the integration of stable isotopes with radiometric dating techniques holds promise in refining the temporal constraints of dolomite formation. As technology continues to evolve, the synergy of these cutting-edge techniques will pave the way for a more nuanced understanding of dolomite geochemistry, opening new avenues for exploration and innovation in the study of these intriguing carbonate rocks.

CONCLUSION

In conclusion, the geochemical characterization of dolomites encompasses a rich tapestry of geological history, spanning from their enigmatic formation mechanisms to their diverse distribution and significance across various settings. The exploration of dolomite geochemistry has evolved through centuries, with pioneers like Déodat de Dolomieu laying the groundwork for subsequent investigations. The mechanisms driving dolomite formation, including primary precipitation, replacement processes, and the intriguing influence of microbial activity, continue to captivate researchers. The intricate dance of geochemical processes, pressure-temperature effects, and fluid-rock interactions shapes the dolomite landscape, leaving behind a mosaic of mineralogical textures and compositions. Dolomite distribution patterns, whether in shallow marine environments, ancient reefs, or subsurface sedimentary basins, serve as silent witnesses to Earth's dynamic past. Their presence in hydrocarbon reservoirs, influencing porosity and permeability, underscores the practical implications of dolomite studies for resource exploration. The application of advanced geochemical analysis techniques, such as stable isotope analysis, elemental composition studies, and high-resolution imaging, has significantly enhanced our ability to unravel the molecular secrets locked within dolomites. These techniques provide windows into the geochemical history, paleo environments, and diagenetic processes that have sculpted these carbonate rocks over geological time scales. Challenges persist, from the intricacies of dolomite distribution studies to the refinement of analytical protocols. However, emerging frontiers, such as synchrotron-based techniques and integrated isotopic dating, hold promise for deeper insights into dolomite geochemistry. As we stand at the nexus of historical knowledge and technological innovation, the geochemical exploration of dolomites offers a multidimensional understanding of Earth's geological processes. From deciphering ancient landscapes to guiding hydrocarbon exploration, the significance of dolomite geochemistry resonates across diverse scientific disciplines, reaffirming the enduring allure of these enigmatic carbonate rocks in the geological narrative.

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RESEARCH ARTICLE

On $\alpha^* g^{\dagger} \psi$ -Continuous Functions and Irresolute Maps in Topological **Spaces**

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ABSTRACT

In this article, we introduce the concept of Alpha star generalized hash psi $(\alpha^* g^{\#} \psi)$ -Continuity in topological spaces and the relationship between $\alpha^* g^{\#} \psi$ -Continuity and other existing sets are derived. Some of its characteristics and also its irresoluteness are discussed.

Keywords: $\alpha^* g^{\#} \psi$ -continuous, $\alpha^* g^{\#} \psi$ -irresolute maps.

MSC: 54C05, 54C10.

INTRODUCTION

N.Levine[8] and A.S.Mashhour[10] introduced the concept of semi-continuous and α -continuous function. Maheshwari and Thakur[9] introduced α -irresolute. Sundaram, H.Maki and Balachandran[13] introduced sgcontinuity. R.Devi[3, 2] developed gs-continuity and ag continuity. Gnanambal[5] introduced gpr-continuity. M.Vigneshwaran[16] developed the concepts of * $g\alpha$ -continuity. Dontchev[4] developed gsp-continuity and Veerakumar[14] introduced and studied ψ -continuity in topological spaces. Kanimozhi, Balamani and Parvathi[7] introduced $g^{\#}\psi$ -continuity and T.Nandhini[11] introduced $\alpha g^{\#}\psi$ -closed sets and continuous functions in topological spaces.





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PRELIMINARIES

Definition 2.1: A function $f:(X, \tau) \to (Y, \sigma)$ is called semi-continuous [8] if $f^{-1}(V)$ is semi-closed in (X, τ) for every closed set V of (Y, σ) . α-continuous [10] if $f^{-1}(V)$ is α -closed in (X, τ) for every closed set V of (Y, σ) . gs-continuous [3] if $f^{-1}(V)$ is gs-closed in (X, τ) for every closed set V of (Y, σ) . gp-continuous [1] if $f^{-1}(V)$ is gp-closed in (X, τ) for every closed set V of (Y, σ) . *gα-continuous [16] if $f^{-1}(V)$ is *gα-closed in (X, τ) for every closed set V of (Y, σ) . sg-continuous [13] if $f^{-1}(V)$ is *gα-closed in (X, τ) for every closed set V of (Y, σ) . αg-continuous [2] if $f^{-1}(V)$ is αg-closed in (X, τ) for every closed set V of (Y, σ) . gsp-continuous [4] if $f^{-1}(V)$ is gsp-closed in (X, τ) for every closed set V of (Y, σ) . gr-continuous [6] if $f^{-1}(V)$ is gr-closed in (X, τ) for every closed set V of (Y, σ) . ψg-continuous [14] if $f^{-1}(V)$ is ψg-closed in (X, τ) for every closed set V of (Y, σ) . ψg-continuous [12] if $f^{-1}(V)$ is ψg-closed in (X, τ) for every closed set V of (Y, σ) . ψ g-continuous [15] if $f^{-1}(V)$ is ψ g-closed in (X, τ) for every closed set V of (Y, σ) . ψ g-continuous [7] if $f^{-1}(V)$ is $g^{\#}$ -closed in (X, τ) for every closed set V of (Y, σ) . φ g\psi -continuous [7] if $f^{-1}(V)$ is φ g\psi-closed in (X, τ) for every closed set V of (Y, σ) . φ g\psi -continuous [7] if $f^{-1}(V)$ is φ g\psi-closed in (X, τ) for every closed set V of (Y, σ) .

Definition 2.2: A function $f:(X, \tau) \to (Y, \sigma)$ is called α-irresolute [9] if $f^{-1}(V)$ is α-closed set in (X, τ) for every α-closed set V of (Y, σ) . $\alpha g^{\#}\psi$ -irresolute [11] if $f^{-1}(V)$ is $\alpha g^{\#}\psi$ -closed set in (X, τ) for every $\alpha g^{\#}\psi$ -closed set V of (Y, σ) .

3. $\alpha^* g^{\dagger} \psi$ -Continuity

Definition 3.1: A function $f:(X, \tau) \to (Y, \sigma)$ is called $\alpha^* g^\# \psi$ -continuous if $f^{-1}(V)$ is $\alpha^* g^\# \psi$ -closed set of (X, τ) for every closed set V of (Y, σ) .

Theorem 3.2: Every continuous map is $\alpha^* g^\# \psi$ -continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is continuous, f^{-1} (V) is closed in (X, τ).

But every closed set is $\alpha^* g^{\#} \psi$ -closed set.

Hence f^{-1} (V) is $\alpha^* g^{\#} \psi$ -closed set in (X, τ).

Thus f is $\alpha^* g^\# \psi$ -continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.3: Let $X = \{a,b,c\} = Y$, $\tau = \{X, \emptyset, \{a,b\}\}$ and $\sigma = \{Y, \emptyset, \{a\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = b, f(b) = a, f(c) = c.

 $\alpha^* g^\# \psi C(X, \tau) = \{X, \emptyset, \{c\}, \{b,c\}, \{a,c\}\}.$

Here, $f^{-1}(\{b, c\}) = \{a, c\}$ is not a closed set in (X, τ) .

Therefore f is not continuous.

However f is $\alpha^* g^{\#} \psi$ -continuous.

Theorem 3.4: Every α -continuous map is $\alpha^* g^{\#} \psi$ -continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is α -continuous, f^{-1} (V) is α -closed in (X, τ).

But every α -closed set is $\alpha^* g^{\#} \psi$ -closed set.

Hence f^{-1} (V) is $\alpha^* g^\# \psi$ -closed set in (X, τ).





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Thus f is $\alpha^* g^\# \psi$ -continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.5: Let $X = \{a, b, c\} = Y$, $\tau = \{X, \emptyset, \{a, b\}\}$ and $\sigma = \{Y, \emptyset, \{a\}, \{a, b\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = c, f(c) = b.

 $\alpha C(X, \tau) = \{X, \emptyset, \{c\}\}.$

 $\alpha^* g^{\#} \psi C(X, \tau) = \{X, \emptyset, \{c\}, \{b, c\}, \{a, c\}\}.$

Here, $f^{-1}(\{c\}) = \{b\}$ is not α -closed set in (X, τ) .

Therefore f is not α -continuous.

However f is $\alpha^* g^{\#} \psi$ -continuous.

Theorem 3.6: Every $\alpha^* g^\# \psi$ -continuous map is gs-continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -continuous, f^{-1} (V) is $\alpha^* g^\# \psi$ -closed in (X, τ).

But every $\alpha^* g^{\#} \psi$ -closed set is gs-closed set.

Hence f^{-1} (V) is gs-closed set in (X, τ).

Thus f is gs-continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.7: Let $X = \{a,b,c\} = Y$, $\tau = \{X, \emptyset, \{b\}, \{a,b\}\}$ and $\sigma = \{Y, \emptyset, \{b\}\}$

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = b, f(b) = c, f(c) = a.

GSC(X, τ) = {X, \emptyset , {a}, {c}, {b, c}, {a, c}}.

 $\alpha^* g^{\#} \psi C(X, \tau) = \{X, \emptyset, \{a\}, \{c\}, \{a, c\}\}.$

Here, f^{-1} ({a, c}) = {b, c} is not $\alpha^* g^\# \psi$ -closed set in (X, τ).

Therefore f is not $\alpha^* g^{\#} \psi$ -continuous.

However f is gs-continuous.

Theorem 3.8: Every $\alpha^* g^\# \psi$ -continuous map is gp-continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -continuous, f^{-1} (V) is $\alpha^* g^\# \psi$ -closed in (X, τ).

But every $\alpha^* g^{\#} \psi$ -closed set is gp-closed set.

Hence f^{-1} (V) is gp-closed set in (X, τ).

Thus f is gp-continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.9: Let $X = \{a, b, c\} = Y$, $\tau = \{X, \emptyset, \{b, c\}\}$ and $\sigma = \{Y, \emptyset, \{a, b\}\}$.

Define $f:(X, \tau) \rightarrow (Y, \sigma)$ by f(a) = a, f(b) = c, f(c) = b.

 $GPC(X, \tau) = \{X, \emptyset, \{a\}, \{b\}, \{c\}, \{a, b\}, \{a, c\}\}.$

 $\alpha^* g^\# \psi C(X, \tau) = \{X, \emptyset, \{a\}, \{a, b\}, \{a, c\}\}.$

Here, $f^{-1}(\{c\}) = \{b\}$ is not $\alpha^* g^\# \psi$ -closed set in (X, τ) .

Therefore f is not $\alpha^* g^{\#} \psi$ -continuous.

However f is gp-continuous.

Theorem 3.10: Every $\alpha^* g^\# \psi$ -continuous map is sg-continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -continuous, f^{-1} (V) is $\alpha^* g^\# \psi$ -closed in (X, τ).

But every $\alpha^* g^\# \psi$ -closed set is sg-closed set.

Hence f^{-1} (V) is sg-closed set in (X, τ).

Thus f is sg-continuous.

Following example shows that the converse of the above theorem need not be true.





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Example 3.11: Let $X = \{a, b, c\} = Y$, $\tau = \{X, \emptyset, \{a\}, \{b\}, \{a, b\}\}$ and $\sigma = \{Y, \emptyset, \{b, c\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = c, f(c) = b.

 $SGC(X, \tau) = \{X, \emptyset, \{a\}, \{b\}, \{c\}, \{b, c\}, \{a, c\}\}.$

 $\alpha^* g^{\#} \psi C(X, \tau) = \{X, \emptyset, \{c\}, \{b, c\}, \{a, c\}\}.$

Here, $f^{-1}(\{a\}) = \{a\}$ is not $\alpha^* g^\# \psi$ -closed set in (X, τ) .

Therefore f is not $\alpha^* g^{\#} \psi$ -continuous.

However f is sg-continuous.

Theorem 3.12: Every $\alpha^* g^\# \psi$ -continuous map is αg -continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -continuous, f^{-1} (V) is $\alpha^* g^\# \psi$ -closed in (X, τ).

But every $\alpha^* g^{\#} \psi$ -closed set is αg -closed set.

Hence f^{-1} (V) is αg -closed set in (X, τ).

Thus f is α g-continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.13: Let $X = \{a, b, c\} = Y$, $\tau = \{X, \emptyset, \{c\}, \{b, c\}\}$ and $\sigma = \{Y, \emptyset, \{b\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = b, f(c) = c.

 $\alpha GC(X,\,\tau) = \{X,\,\emptyset,\,\{a\},\,\{b\},\,\{a,\,b\},\,\{a,\,c\}\}.$

 $\alpha^* g^{\#} \psi C(X, \tau) = \{X, \emptyset, \{a\}, \{b\}, \{a, b\}\}.$

Here, f^{-1} ({a, c}) = {a, c} is not $\alpha^* g^\# \psi$ -closed set in (X, τ).

Therefore f is not $\alpha^* g^\# \psi$ -continuous.

However f is α g-continuous.

Theorem 3.14: Every *g α -continuous map is $\alpha^*g^{\#}\psi$ -continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is *g α continuous, f^{-1} (V) is *g α -closed in (X, τ).

But every * $g\alpha$ -closed set is $\alpha^*g^*\psi$ -closed set.

Hence f^{-1} (V) is $\alpha^* g^{\#} \psi$ -closed set in (X, τ).

Thus f is $\alpha^* g^\# \psi$ -continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.15: Let $X = \{a, b, c\} = Y$, $\tau = \{X, \emptyset, \{a\}\}$ and $\sigma = \{Y, \emptyset, \{a, c\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = c, f(c) = b.

* $G\alpha C(X, \tau) = \{X, \emptyset, \{b, c\}\}.$

 $\alpha^* g^\# \psi C(X, \tau) = \{X, \emptyset, \{b\}, \{c\}, \{b, c\}\}.$

Here, $f^{-1}(\{b\}) = \{c\}$ is not *g\alpha -closed set in (X, \tau).

Therefore f is not * $g\alpha$ -continuous.

However f is $\alpha^* g^\# \psi$ -continuous.

Theorem 3.16: Every $\alpha^* g^{\#} \psi$ -continuous map is gsp-continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -continuous, f^{-1} (V) is $\alpha^* g^\# \psi$ -closed in (X, τ).

But every $\alpha^* g^{\#} \psi$ -closed set is gsp-closed set.

Hence f^{-1} (V) is gsp-closed set in (X, τ).

Thus f is gsp-continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.17: Let $X = \{a, b, c\} = Y$, $\tau = \{X, \emptyset, \{a, b\}\}$ and $\sigma = \{Y, \emptyset, \{a, c\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = b, f(b) = c, f(c) = a.





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GSPC(X, τ) = {X, \emptyset , {a}, {b}, {c}, {b, c}, {a, c}}.

 $\alpha^* g^\# \psi C(X, \tau) = \{X, \emptyset, \{c\}, \{b, c\}, \{a, c\}\}.$

Here, f^{-1} ({b}) = {a} is not $\alpha^* g^\# \psi$ -closed set in (X, τ).

Therefore f is not $\alpha^* g^{\#} \psi$ -continuous.

However f is gsp-continuous.

Theorem 3.18: Every $\alpha^* g^\# \psi$ -continuous map is g^* sp-continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -continuous, f^{-1} (V) is $\alpha^* g^\# \psi$ -closed in (X,):

But every *#p/closed set is g*sp-closed set.

Hence \mathcal{T}^1 (V) is g*sp-closed set in (X,):

Thus f is g*sp-continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.19: Let $X = \{a, b, c\} = Y$, $\neq \{X, \emptyset, \{a\}, \{a, b\}\}\$ and $\neq \{Y, \emptyset, \{a\}\}.$

Define $f:(X, Y \rightarrow (Y, Y) \text{ by } f(a) = b$, f(b) = a, f(c) = c.

 $G*SPC(X, y=\{X, \emptyset, \{b\}, \{c\}, \{b, c\}, \{a, c\}\}.$

*# $\mathcal{D}(X,) = \{X, \emptyset, \{b\}, \{c\}, \{b, c\}\}.$

Here, \mathcal{T}^1 ({b, c}) = {a, c} is not $\frac{a}{a}$ /closed set in (X,):

Therefore f is not *#ppcontinuous.

However f is g*sp-continuous.

Theorem 3.20: Every theorem is gpr-continuous.

Proof: Let V be a closed set of (Y,)

Since f is *#\psi\phi\ontinuous, f^{-1} (V) is $\alpha^*g^*\psi$ -closed in (X, τ) .

But every $\alpha^* g^\# \psi$ -closed set is gpr-closed set.

Hence f^{-1} (V) is gpr-closed set in (X, τ).

Thus f is gpr-continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.21: Let $X = \{a, b, c\} = Y$, $\tau = \{X, \emptyset, \{b\}\}\$ and $\sigma = \{Y, \emptyset, \{b\}\}\$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = c, f(c) = b.

GPRC(X, τ) = {X, \emptyset , {a}, {b}, {c}, {a, b}, {b, c}, {a, c}}.

 $\alpha^* g^\# \psi C(X, \tau) = \{X, \emptyset, \{a\}, \{c\}, \{a, c\}\}.$

Here, f^{-1} ({a, c}) = {a, b} is not $\alpha^* g^\# \psi$ -closed set in (X, τ).

Therefore f is not $\alpha^* g^\# \psi$ -continuous.

However f is gpr-continuous.

Theorem 3.22: Every $\alpha^* g^\# \psi$ -continuous map is ψg -continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha^* g^{\#} \psi$ -continuous, f^{-1} (V) is $\alpha^* g^{\#} \psi$ -closed in (X, τ).

But every $\alpha^* g^{\#} \psi$ -closed set is ψ g-closed set.

Hence f^{-1} (V) is ψ g-closed set in (X, τ).

Thus f is ψ g-continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.23: Let $X = \{a, b, c\} = Y$, $\tau = \{X, \emptyset, \{a\}, \{a, b\}\}$ and $\sigma = \{Y, \emptyset, \{a\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = c, f(b) = a, f(c) = b.

 ψ GC(X, τ) = {X, \emptyset , {b}, {c}, {a, c}, {b, c}}.

 $\alpha^* g^{\#} \psi C(X, \tau) = \{X, \emptyset, \{b\}, \{c\}, \{b, c\}\}.$

Here, f^{-1} ({b, c}) = {a,c} is not $\alpha^* g^\# \psi$ -closed set in (X, τ).





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Therefore f is not $\alpha^* g^{\#} \psi$ -continuous.

However f is ψ g-continuous.

Theorem 3.24: Every $g^{\#}$ -continuous map is $\alpha^* g^{\#} \psi$ -continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $g^{\#}$ -continuous, $f^{-1}(V)$ is $g^{\#}$ -closed in (X, τ) .

But every $g^{\#}$ -closed set is $\alpha^*g^{\#}\psi$ -closed set.

Hence f^{-1} (V) is $\alpha^* g^\# \psi$ -closed set in (X, τ).

Thus f is $\alpha^* g^\# \psi$ -continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.25: Let $X = \{a,b,c\} = Y$, $\tau = \{X, \emptyset, \{c\}, \{a,b\}\}$ and $\sigma = \{Y, \emptyset, \{a,b\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = c, f(c) = b.

 $g^{\#}C(X, \tau) = \{X, \emptyset, \{c\}, \{a, b\}\}.$

 $\alpha^* g^\# \psi C(X, \tau) = \{X, \emptyset, \{a\}, \{b\}, \{c\}, \{a, b\}, \{b, c\}, \{a, c\}\}.$

Here, $f^{-1}(\{c\}) = \{b\}$ is not $g^{\#}$ -closed set in (X, τ) .

Therefore f is not $g^{\#}$ -continuous.

However f is $\alpha^* g^{\#} \psi$ -continuous.

Theorem 3.26: Every $\alpha^* g^\# \psi$ -continuous map is $g^\# \psi$ -continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -continuous, f^{-1} (V) is $\alpha^* g^\# \psi$ -closed in (X, τ).

But every $\alpha^* g^{\#} \psi$ -closed set is $g^{\#} \psi$ -closed set.

Hence f^{-1} (V) is $g^{\#}\psi$ -closed set in (X, τ).

Thus f is $g^{\#}\psi$ -continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.27: Let $X = \{a,b,c\} = Y$, $\tau = \{X, \emptyset, \{a\}, \{b\}, \{a,b\}\} \text{ and } \sigma = \{Y, \emptyset, \{b,c\}\}.$

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = b, f(c) = c.

 $g^{\#}\psi C(X, \tau) = \{X, \emptyset, \{a\}, \{b\}, \{c\}, \{b, c\}, \{a, c\}\}.$

 $\alpha^* g^\# \psi C(X, \tau) = \{X, \emptyset, \{c\}, \{b, c\}, \{a, c\}\}.$

Here, $f^{-1}(\{a\}) = \{a\}$ is not $\alpha^* g^\# \psi$ -closed set in (X, τ) .

Therefore f is not $\alpha^* g^\# \psi$ -continuous.

However f is $g^{\#}\psi$ -continuous.

Theorem 3.28: Every $\alpha g^{\#}\psi$ -continuous map is $\alpha^*g^{\#}\psi$ -continuous.

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha g^{\#}\psi$ -continuous, f^{-1} (V) is $\alpha g^{\#}\psi$ -closed in (X, τ).

But every $\alpha g^{\#}\psi$ -closed set is $\alpha^*g^{\#}\psi$ -closed set.

Hence f^{-1} (V) is $\alpha^* g^\# \psi$ -closed set in (X, τ) .

Thus f is $\alpha^* g^\# \psi$ -continuous.

Following example shows that the converse of the above theorem need not be true.

Example 3.29: Let $X = \{a, b, c\} = Y$, $\tau = \{X, \emptyset, \{b\}, \{a, c\}\}$ and $\sigma = \{Y, \emptyset, \{a\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = c, f(b) = b, f(c) = a.

 $\alpha g^{\#} \psi C(X, \tau) = \{X, \emptyset, \{b\}, \{a, c\}\}.$

 $\alpha^*g^\#\psi C(X,\tau) = \{X,\,\emptyset,\,\{a\},\,\{b\},\,\{c\},\,\{a,\,b\},\,\{b,\,c\},\,\{a,\,c\}\}.$

Here, $f^{-1}(\{b, c\}) = \{a, b\}$ is not $\alpha g^{\#}\psi$ -closed set in (X, τ) .

Therefore f is not $\alpha g^{\#}\psi$ -continuous.

However f is $\alpha^* g^\# \psi$ -continuous.





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Remark 3.30: $\alpha^* g^\# \psi$ -Continuity is independent of semi-Continuity and ψ -Continuity. It can be shown by the example.

Example 3.31: Let X = {a, b, c} = Y , τ = {X, ∅, {a}, {b}, {a, b}} and σ = {Y , ∅, {b, c}}. Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = b, f(b) = a, f(c) = c. $SC(X, \tau) = {X, ∅, {a}, {b}, {c}, {b, c}, {a, c}} = C(X, \tau)$ $α*g#ψC(X, τ) = {X, ∅, {c}, {b, c}, {a, c}} = C(X, \tau)$ Here, f^{-1} ({a}) = {b} is not α*g#ψ -closed set in (X,). Therefore f is not α*g#ψ -continuous. However f is semi-continuous and ψ-continuous. Let $X = {a, b, c} = Y$, $τ = {X, ∅, {c}, {a, b}}$ and $σ = {Y, ∅, {c}}$. Define $f:(X, τ) \to (Y, σ)$ by f(a) = c, f(b) = b, f(c) = a. $SC(X, τ) = {X, ∅, {c}, {a, b}} = C(X, τ)$. $α*g#ψC(X, τ) = {X, ∅, {a}, {b}, {c}, {a, b}, {b, c}, {a, c}}$. Here, f^{-1} ({a, b}) = {b, c} is not semi-closed set and -closed set in (X, τ). Therefore f is not semi-continuous and ψ-continuous. However f is α*g#ψ-continuous.

Remark 3.32: The composition of two $\alpha^* g^\# \psi$ -continuous map need not be a $\alpha^* g^\# \psi$ -continuous. It can be shown by the example.

Example 3.33: Let $X = \{a,b,c\} = Y = Z$, $\tau = \{X, \emptyset, \{a\}, \{a, b\}\}, \sigma = \{Y, \emptyset, \{a, b\}\}, \eta = \{Z, \emptyset, \{b\}, \{b, c\}\}\}$ Define f:(X, τ) → (Y, σ) by f(a) = a, f(b) = b, f(c) = c. Define g: (Y, σ) → (Z, η) by g(a) = c, g(b) = b, g(c) = a. $\alpha^* g^\# \psi C(X, \tau) = \{X, \emptyset, \{b\}, \{c\}, \{b, c\}\}.$ $\alpha^* g^\# \psi C(Y, \sigma) = \{Y, \emptyset, \{c\}, \{b, c\}, \{a, c\}\}.$ Both f and g are $\alpha^* g^\# \psi$ -continuous. Here {a, c} is a closed set in (Z, η). But (gof)⁻¹ ({a, c}) = {a, c} is not $\alpha^* g^\# \psi$ -closed set in (X, τ). Therefore gof is not $\alpha^* g^\# \psi$ -continuous.

4. $\alpha^* g^{\#} \psi$ -Irresoluteness

Definition 4.1: A function $f:(X, \tau) \to (Y, \sigma)$ is called $\alpha^* g^\# \psi$ -irresolute if $f^{-1}(V)$ is $\alpha^* g^\# \psi$ -closed set of (X, τ) for every $\alpha^* g^\# \psi$ -closed set V of (Y, σ) .

Theorem 4.2: Every $\alpha^* g^\# \psi$ -irresolute is $\alpha^* g^\# \psi$ -continuous.

Proof: Let V be a closed set of (Y, σ) .

Since every closed set is $\alpha^* g^\# \psi$ -closed set.

Therefore V is $\alpha^* g^\# \psi$ -closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -irresolute, $f^{-1}(V)$ is $\alpha^* g^\# \psi$ -closed set in (X, τ) .

Therefore f is $\alpha^* g^\# \psi$ -continuous.

Following example shows that the converse of the above theorem need not be true.

Example 4.3: Let $X = \{a, b, c\} = Y$, with $\tau = \{X, \emptyset, \{b\}, \{b, c\}\}$ and $\sigma = \{Y, \emptyset, \{a, b\}\}$. Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = b, f(b) = a, f(c) = c. $\alpha^* g^\# \psi C(X, \tau) = \{X, \emptyset, \{a\}, \{c\}, \{a, c\}\}.$ $\alpha^* g^\# \psi C(Y, \sigma) = \{Y, \emptyset, \{c\}, \{b, c\}, \{a, c\}\}.$





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Here f is $\alpha^* g^{\#} \psi$ -continuous but f is not $\alpha^* g^{\#} \psi$ -irresolute.

Since {a, c} is $\alpha^* g^\# \psi$ -closed set in (Y, σ) but $f^{-1}(\{a, c\}) = \{b, c\}$ is not a $\alpha^* g^\# \psi$ -closed set in (X, τ).

Theorem 4.4: Let $f:(X, \tau) \to (Y, \sigma)$ and $g:(Y, \sigma) \to (Z, \eta)$ be any two functions. Then

(i) $gof:(X, \tau) \to (Z, \eta)$ is $\alpha^* g^{\#} \psi$ -continuous if g is continuous and f is $\alpha^* g^{\#} \psi$ -continuous.

(ii) $gof:(X, \tau) \to (Z, \eta)$ is $\alpha^* g^\# \psi$ -irresolute if both g and f are $\alpha^* g^\# \psi$ -irresolute.

(iii) $gof:(X, \tau) \to (Z, \eta)$ is $\alpha^* g^\# \psi$ -continuous if g is $\alpha^* g^\# \psi$ -continuous and f is $\alpha^* g^\# \psi$ -irresolute.

Proof:

(i) : Let V be a closed set in (Z, η) .

Since g is continuous, g^{-1} (V) is closed in (Y, σ).

Since f is $\alpha^* g^\# \psi$ -continuous, $f^{-1}(g^{-1}(V)) = (g \circ f)^{-1}(V)$ is $\alpha^* g^\# \psi$ -closed in (X, τ) .

Therefore gof is $\alpha^* g^{\#} \psi$ -continuous.

(ii) : Let V be a $\alpha^* g^{\#} \psi$ -closed set in (Z, η) .

Since g and f are $\alpha^* g^\# \psi$ -irresolute, $f^{-1}(g^{-1}(V)) = (gof)^{-1}(V)$ is $\alpha^* g^\# \psi$ -closed in (X, τ) .

Therefore gof is $\alpha^*g^{\#}\psi$ -irresolute.

(iii): Let V be a closed set in (Z, η) .

Since g is $\alpha^* g^\# \psi$ -continuous, g^{-1} (V) is $\alpha^* g^\# \psi$ -closed in (Y, σ).

Since f is $\alpha^* g^\# \psi$ -irresolute, $f^{-1}(g^{-1}(V)) = (g \circ f)^{-1}(V)$ is $\alpha^* g^\# \psi$ -closed in (X, τ) .

Therefore gof is $\alpha^* g^{\#} \psi$ -continuous.

Theorem 4.5: Let f:(X, τ) → (Y, σ) be a $\alpha^* g^\# \psi$ -continuous(resp $\alpha^* g^\# \psi$ -continuous, $\alpha^* g^\# \psi$ -continuous) map. If (X, τ) is an $T_{\alpha^* g^\# \psi}$ (resp $T_{\alpha^* g^\# \psi}^*$, $T_{\alpha^* g^\# \psi}^{**}$) space, then f is continuous(α-continuous, $\alpha g^\# \psi$ -continuous).

Proof: Let V be a closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -continuous(resp $\alpha^* g^\# \psi$ -continuous, $\alpha^* g^\# \psi$ -continuous), f^{-1} (V) is $\alpha^* g^\# \psi$ -closed(resp $\alpha^* g^\# \psi$ -closed, $\alpha^* g^\# \psi$ -closed) in (X, τ) .

Since (X, τ) is an $T_{\alpha^* g^\# \psi}$ (resp $T_{\alpha^* g^\# \psi}^*$, $T_{\alpha^* g^\# \psi}^{**}$) space, f^{-1} (V) is closed(α -closed, $\alpha g^\# \psi$ -closed) in (X, τ) .

Therefore f is continuous(α -continuous, $\alpha g^{\#}\psi$ -continuous).

Theorem 4.6: Let $f:(X, \tau) \to (Y, \sigma)$ be a surjective, $\alpha g^{\#} \psi$ -irresolute and a closed map. Then f(A) is $\alpha^* g^{\#} \psi$ -closed set of (Y, σ) for every $\alpha^* g^{\#} \psi$ -closed set A of (X, τ) .

Proof: Let A be a $\alpha^* g^\# \psi$ -closed set of (X, τ) .

Let U be a $\alpha g^{\#} \psi$ - open set of (Y, σ) such that $f(A) \subseteq U$.

Since f is surjective and $\alpha g^{\#}\psi$ -irresolute, f^{-1} (U) is a $\alpha g^{\#}\psi$ - open set of (X, τ) .

Since $A \subseteq f^{-1}$ (U) and A is $\alpha^* g^\# \psi$ -closed set of (X, τ) , $\alpha \operatorname{cl}(A) \subseteq f^{-1}$ (U).

Then $f(\alpha cl(A)) \subseteq f(f^{-1}(U)) = U$.

Since f is α -closed, $f(\alpha cl(A)) = \alpha cl(f(\alpha cl(A)))$.

 $\Rightarrow \alpha \operatorname{cl}(f(A)) \subseteq \alpha \operatorname{cl}(f(\alpha \operatorname{cl}(A))) = f(\alpha \operatorname{cl}(A)) \subseteq U.$

Therefore f(A) is a $\alpha^* g^{\#} \psi$ -closed set of (Y, σ) .

Theorem 4.7: Let $f:(X, \tau) \to (Y, \sigma)$ be a surjective, $\alpha^* g^\# \psi$ -irresolute and a closed map. If

 (X, τ) is a $T_{\alpha^* \alpha^\# \psi}$ space, then (Y, σ) is also a $T_{\alpha^* \alpha^\# \psi}$ space.

Proof: Let A be a $\alpha^* g^{\#} \psi$ -closed set of (Y, σ) .

Since f is $\alpha^* g^{\#} \psi$ -irresolute, f^{-1} (A) is a $\alpha^* g^{\#} \psi$ -closed set of (X, τ).

Since (X, τ) is an $T_{\alpha^* g^{\#} \psi}$ space, $f^{-1}(A)$ is a closed set of (X, τ) .

Then $f(f^{-1}(A)) = A$ is closed in (Y, σ) .

Thus A is closed set of (Y, σ) .

Therefore (Y, σ) is an $T_{\alpha^* q^\# \psi}$ - space.





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Definition 4.8: A function $f:(X, \tau) \to (Y, \sigma)$ is called pre- $\alpha^* g^\# \psi$ -closed if f(A) is $\alpha^* g^\# \psi$ -closed set of (Y, σ) for every $\alpha^* g^\# \psi$ -closed set A of (X, τ) .

Theorem 4.9: Let $f:(X, \tau) \to (Y, \sigma)$ be a surjective, $\alpha^* g^\# \psi$ –irresolute and a pre- α -closed map. If (X, τ) is an $T^*_{\alpha^* g^\# \psi}$ space, then (Y, σ) is also an $T^*_{\alpha^* g^\# \psi}$ space.

Proof: Let A be a $\alpha^* g^{\#} \psi$ -closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -irresolute, f^{-1} (A) is a $\alpha^* g^\# \psi$ -closed set of (X, τ) .

Since (X, τ) is an $T^*_{\alpha^* \alpha^{\#} 1 b}$ space, f^{-1} (A) is a α -closed set of (X, τ) .

Since f is pre- α -closed map, $f(f^{-1}(A))$ is α -closed in (Y, σ) for every α -closed set of $f^{-1}(A)$ of (X, τ) .

Since f is surjection, $A = f(f^{-1}(A))$.

Thus A is a α -closed set in (Y, σ) .

Therefore (Y, σ) is an $T^*_{\alpha^* \sigma^{\#} y b}$ space.

Theorem 4.10: Let $f:(X, \tau) \to (Y, \sigma)$ be a surjective, $\alpha^* g^\# \psi$ -irresolute and a pre- $\alpha g^\# \psi$ -closed map. If (X, τ) is an $T^{**}_{\alpha^* g^\# \psi}$ space, then (Y, σ) is also an $T^{**}_{\alpha^* g^\# \psi}$ space.

Proof: Let A be a $\alpha^* g^{\#} \psi$ -closed set of (Y, σ) .

Since f is $\alpha^* g^\# \psi$ -irresolute, f^{-1} (A) is a $\alpha^* g^\# \psi$ -closed set of (X, τ).

Since (X, τ) is an $T_{\alpha^* q^\# \psi}^{**}$ space, f^{-1} (A) is a $\alpha g^\# \psi$ -closed set of (X, τ) .

Since f is pre- $\alpha g^{\#}\psi$ - closed map, $f(f^{-1}(A))$ is $\alpha g^{\#}\psi$ -closed in (Y, σ) for every $\alpha g^{\#}\psi$ -closed set of $f^{-1}(A)$ of (X, τ) .

Since f is surjection, $A = f(f^{-1}(A))$.

Thus A is a $\alpha g^{\#}\psi$ -closed set in (Y, σ) .

Therefore (Y, σ) is an $T_{\alpha^*q^\#\psi}^{**}$ space.

5. $\alpha^* g^{\#} \psi$ - Homeomorphisms

Definition 5.1: A function $f:(X, \tau) \to (Y, \sigma)$ is said to be $\alpha^* g^\# \psi$ -open if the image f(U) is $\alpha^* g^\# \psi$ -open in (Y, σ) for every open set U of (X, τ) .

Example 5.2: Let $X = \{a, b, c\} = Y$, with $\tau = \{X, \emptyset, \{b\}, \{b, c\}\}$ and $\sigma = \{Y, \emptyset, \{a\}, \{b, c\}\}$.

Then $\alpha^* g^\# \psi$ -open set of $(Y, \sigma) = \{Y, \emptyset, \{a\}, \{b\}, \{c\}, \{a, b\}, \{b, c\}, \{a, c\}\}.$

Let $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = b, f(c) = c.

Then f is $\alpha^* g^\# \psi$ -open.

Definition 5.3: A function $f:(X, \tau) \to (Y, \sigma)$ is said to be $\alpha^* g^\# \psi$ -closed if the image f(U) is $\alpha^* g^\# \psi$ -closed in (Y, σ) for every closed set U of $a(X, \tau)$.

Example 5.4: Let $X = \{a, b, c\} = Y$, with $\tau = \{X, \emptyset, \{b\}, \{b, c\}\}$ and $\sigma = \{Y, \emptyset, \{a\}, \{b, c\}\}$.

Then closed sets of $(X, \tau) = \{X, \emptyset, \{a, c\}, \{a\}\}.$

 $\alpha^* g^{\#} \psi$ -open set of $(Y, \sigma) = \{Y, \emptyset, \{a\}, \{b\}, \{c\}, \{a, b\}, \{b, c\}, \{a, c\}\}.$

Let $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = b, f(c) = c.

Then f is $\alpha^* g^\# \psi$ -closed.

Definition 5.5: A bijective function $f:(X, \tau) \to (Y, \sigma)$ is said to be $\alpha^* g^\# \psi$ -homeomorphism if f and f^{-1} are both $\alpha^* g^\# \psi$ -continuous.

Definition 5.6: A bijective function $f:(X, \tau) \to (Y, \sigma)$ is said to be $\alpha^* g^\# \psi C$ -homeomorphism if f and f^{-1} are $\alpha^* g^\# \psi$ -irresolute.





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Theorem 5.7: Every open function is $\alpha^* g^{\#} \psi$ -open.

Proof: Let A be an open set in (X, τ) .

Since f is an open function, f(A) is open set in (Y, σ) .

But every open set is a $\alpha^* g^{\#} \psi$ -open set.

Therefore f(A) is a $\alpha^* g^\# \psi$ -open set in (Y, σ) .

Hence f is a $\alpha^* g^{\#} \psi$ -open function. Following example shows that the converse of the above theorem need not be true.

Example 5.8: Let $X = \{a,b,c\} = Y$, with $\tau = \{X, \emptyset, \{b\}, \{b,c\}\}$ and $\sigma = \{Y, \emptyset, \{a\}, \{b,c\}\}$.

Then $\alpha^* g^\# \psi$ -open set of $(Y, \sigma) = \{Y, \emptyset, \{a\}, \{b\}, \{c\}, \{a, b\}, \{b, c\}, \{a, c\}\}\}$.

Let $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = b, f(c) = c.

Then f is σ -open function but not an open function,

since $f({a, c}) = {a, c}$ is not an open set in (Y, σ) .

Theorem 5.9: Every homeomorphism is $\alpha^* g^\# \psi$ -homeomorphism.

Proof: Let $f:(X, \tau) \to (Y, \sigma)$ be a homeomorphism.

Since f is homeomorphism, f is bijective where f is both open and continuous.

Also every open set is $\alpha^* g^{\#} \psi$ -open set and every continuous function is $\alpha^* g^{\#} \psi$ -continuous.

From above we have f is bijective, $\alpha^*g^*\psi$ -open and $\alpha^*g^*\psi$ -continuous.

 \Rightarrow f is $\alpha^* g^{\#} \psi$ -homeomorphism.

Following example shows that the converse of the above theorem need not be true.

Example 5.10: Let $X = \{a,b,c\} = Y$, $\tau = \{X, \emptyset, \{a,b\}\}$ and $\sigma = \{Y, \emptyset, \{a\}\}$.

Define $f:(X, \tau) \to (Y, \sigma)$ by f(a) = a, f(b) = b, f(c) = c.

 $\alpha^* g^{\#} \psi C(X, \tau) = \{X, \emptyset, \{c\}, \{b, c\}, \{a, c\}\}.$

 $\alpha^* g^{\#} \psi C(Y, \sigma) = \{Y, \emptyset, \{b\}, \{c\}, \{b, c\}\}.$

Then f is $\alpha^* g^{\#} \psi$ -homeomorphism but not homeomorphism,

since $f(\{a, b\}) = \{a, b\}$ is not a open set in (Y, σ) .

Theorem 5.11: If f is a homeomorphism, then f and f^{-1} are $\alpha^* g^\# \psi$ -irresolute.

Proof: To prove f^{-1} is $\alpha^* g^\# \psi$ -irresolute, let A be a $\alpha^* g^\# \psi$ -closed set of (X, τ) .

To prove $(f^{-1})^{-1}$ (A) = f(A) is $\alpha^* g^\# \psi$ -closed in (Y, σ), let U be a $\alpha^* g^\# \psi$ -open set such that f(A) \subseteq U.

Then A = $(f^{-1}(f(A)) \subseteq f^{-1}(U))$ is $\alpha g^{\#}\psi$ -open.

Since A is $\alpha^* g^\# \psi$ -closed, $\alpha \operatorname{cl}(A) \subseteq f^{-1}(U)$,

we have $\alpha \operatorname{cl}(f(A)) \subseteq f(\alpha \operatorname{cl}(A)) \subseteq f(f^{-1}(U)) = U$ and so f(A) is $\alpha^* g^\# \psi$ -closed.

Thus f^{-1} is $\alpha^* g^\# \psi$ -irresolute.

Since f^{-1} is also a homeomorphism $(f^{-1})^{-1} = f$ is $\alpha^* q^\# \psi$ -irresolute.

Theorem 5.12: Every $\alpha^* g^{\#} \psi C$ -homeomorphism is $\alpha^* g^{\#} \psi$ -homeomorphism.

Proof: Let f is bijective. Since f is $\alpha^* g^\# \psi$ C-homeomorphism, f and f^{-1} are $\alpha^* g^\# \psi$ -irresolute.

Also every $\alpha^* g^\# \psi$ -irresolute map is $\alpha^* g^\# \psi$ -continuous, f and f^{-1} are $\alpha^* g^\# \psi$ -continuous.

Therefore f is $\alpha^* g^{\#} \psi$ -homeomorphism.

Theorem 5.13: Let $f:(X, \tau) \to (Y, \sigma)$ be a bijective and $\alpha^* g^\# \psi$ -continuous

function, then the following are equivalent.

- (i) f is $\alpha^* g^{\#} \psi$ -open function,
- (ii) f is $\alpha^* q^\# \psi$ -homeomorphism,
- (iii) f is $\alpha^* g^\# \psi$ -closed function.





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Proof:

 $(i) \Longrightarrow (ii)$:

Suppose f is $\alpha^*g^*\psi$ -open function, then f is bijective and $\alpha^*g^*\psi$ -continuous function.

By definition of $\alpha^* g^{\#} \psi$ -homeomorphism, f is $\alpha^* g^{\#} \psi$ -homeomorphism.

(ii) \Rightarrow (iii): Since f is $\alpha^* g^\# \psi$ -homeomorphism, f is bijective and also f is $\alpha^* g^\# \psi$ -open and $\alpha^* g^\# \psi$ -continuous.

Let f be a closed set of (X, τ) , then f^c is open set in (X, τ) .

Since f is $\alpha^* g^\# \psi$ -open function, $f(f^c)$ is $\alpha^* g^\# \psi$ -open in (Y, σ) .

Thus $f((f^c)) = ((f(f))^c)$ is $\alpha^* g^\# \psi$ -open set in (Y, σ) .

Thus f(f) is $\alpha^* g^\# \psi$ -closed set in (Y, σ) .

Hence f is $\alpha^* g^{\#} \psi$ -closed function.

(iii) \Rightarrow (i): Suppose f is $\alpha^* g^\# \psi$ -closed function.

Let A be a closed set in (X, τ) .

Since f is $\alpha^* g^\# \psi$ -closed function, f(A) is $\alpha^* g^\# \psi$ -closed set in (Y, σ) from

which $f(A) = (f^{-1})^{-1}(A)$ is $\alpha^* g^\# \psi$ -closed set in (Y, σ) .

 $\Rightarrow f^{-1}$ is $\alpha^* g^{\#} \psi$ -continuous on (Y, σ) .

By hypothesis, f is $\alpha^* g^{\#} \psi$ -open function.

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RESEARCH ARTICLE

Rejuvenating Effects of Nature on Learners' Learning and Wellbeing

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ABSTRACT

The presence of nature is acknowledged for its revitalizing effect on human experiences, providing advantages in physiological, psychological, social, occupational, and quality of life aspects. This review explores the multifaceted advantages of nature exposure, particularly in educational settings, emphasizing the intricate interplay between natural environments and cognitive, emotional, and physical well-being. Highlights the positive impact of outdoor nature-based learning, historical methods of direct observation, and the influence of nature views through windows. Furthermore, it explores the attention restoration theory, illustrating how exposure to nature enhances attention, working memory, and overall student engagement. The role of indoor natural elements, such as plants, is discussed in relation to improved cognitive capacities. The therapeutic potential of nature walks is explored, emphasizing the positive effects on mental health, academic engagement, and a deeper connection with the natural world. Emphasizes the crucial significance of incorporating nature-based interventions into educational curricula and workplaces in order to enhance the well-being and academic performance of learners in a world that is becoming more urbanized and technologically advanced.

Keywords: Rejuvenating Effects, Nature, Learners, Learning and Wellbeing.

INTRODUCTION

Nature's presence is often characterized as having an invigorating and inspiring effect on human experience. The term "nature" is commonly employed to refer to a diverse range of outside situations. The definitions of "nature" often encompass the intricate distinction between landscapes that have been impacted by human activity and those that have not. Despite the frequent oversight or exploitation by humans, nature holds significance for individuals. Natural settings, often known as green spaces, refer to areas of land that are not heavily built and have natural





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vegetation. These areas can include parks, forests, rivers, and playing fields (1). Providing instruction in natural environments can yield significant advantages for pupils (2). The presence of visual exposure to nature has been widely recognised as advantageous in various situations(3). Bonham, et al., (4) found evidences of physiological, psychological, social, vocational and quality of life benefits from participation in nature-based therapies in the literature. There is a growing body of research indicating that the presence of green spaces in one's surroundings has a beneficial impact on one's health (5-7). Specifically, the presence of natural open spaces offers chances for individuals to unwind, engage in social connections, and participate in physical exercises (8). In the contemporary educational landscape, there is a growing recognition of the profound impact that nature can have on learners' learning experiences and overall well-being. This review article delves into the rejuvenating effects of nature on learners, exploring the intricate interplay between natural environments and cognitive, emotional, and physical well-being. As urbanization and technological advancements continue to shape educational settings, understanding the positive influence of nature becomes increasingly crucial. The article also considers practical implications for educators and policymakers seeking to integrate nature-based interventions into educational settings, fostering environments that optimize both academic achievement and the overall well-being of learners.

Outdoor nature-based learning

In ancient times, children acquired knowledge about the physical world by directly observing and analyzing their natural surroundings. Over the past twenty years, numerous studies have demonstrated that outdoor education programs have a beneficial impact on the attitudes, motivation, and self-efficacy of both students and teachers (9). Engaging in outdoor activities in landscaped play areas has a beneficial impact on children's social growth, physical coordination, focus, and energy level. Additionally, it can offer youngsters opportunities to engage with natural environments, perhaps influencing their ethical principles, beliefs, and behaviors. School yards can facilitate the education of children and serve as a secure environment where parental worries about safety and potential dangers do not hinder play. According to the findings of Marchant et al. (10), regularly taking students outside resulted in a higher level of job satisfaction among teachers. According to Chou and Hung (11), it is found that urban living have a detrimental impact on mental health and overall well-being. Residing in urban areas is linked to an elevated susceptibility to many mental health conditions, including mood and anxiety disorders, schizophrenia, as well as feelings of loneliness, isolation, and heightened levels of stress (12-14). Evidence from studies conducted by Rideout (15-17) indicates that both children aged 0-8 years and adolescents are devoting more and more time to screen and media consumption. This diminishes the amount of time people are able to allocate towards developing the fundamental aspects of social, emotional, physical, and mental well-being (18).

Children tend to remember and retain more information when they have lessons in natural environments, specifically in subjects like biology and maths (19). This effect is also shown in language arts, social studies, and science in general (20), compared to classes conducted inside. Kuo et al. (21) recorded that consistent engagement in 30-minute forest walks once a week over a certain duration resulted in gradual and accumulated advantages. During the Covid-19 period, when actual interaction with nature is limited, new forms of tourism have arisen that allow individuals to electronically engage with nature in order to improve their health and well-being (21). Xu et al. (22) discovered that watching nature-based films on social media influences people's emotional and cognitive states. Learners have a preference for and derive more enjoyment from lessons conducted outdoors rather than indoors (23, 24). Furthermore, there is evidence indicating that outdoor nature-based learning promotes a higher level of interest in school and learning in general (25). Kuo et al. (26) discovered a substantial correlation between the amount of greenery, specifically the tree cover in schools, and maths achievement. There was also a somewhat significant correlation between greenery and reading performance. Tendencies were detected that regular compulsory schooland curriculum-based Outdoor Education Programmes (OEPs) can promote students in respect of social, academic, physical and psychological dimensions (27). Zhang et al., (28) found that passion for outdoor activities affects employees' life, workplace, and psychological well-being in numerous ways. Business managers can emphasise the benefits of outdoor activities and nature connectedness for employees to reduce stress, increase attention, and boost well-being. Historical method of children learning from direct observation of nature has been reaffirmed by contemporary research showcasing the manifold benefits of outdoor education programs on both students and





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teachers. Engaging in outdoor activities not only fosters social growth, physical coordination, and focus among children but also provides a platform for ethical and behavioral influence through interactions with natural environments. School yards emerge as secure spaces for education, positively impacting teacher satisfaction. The significance of outdoor learning extends across various subjects, promoting retention and interest, while greenery in schools correlates with academic achievement. Recognizing the multifaceted advantages, integrating outdoor education into school curricula and workplaces becomes pivotal for overall well-being.

Effect of nature via window views

Research has demonstrated that observing peaceful nature surroundings might enhance cognitive functions and decrease physiological arousal (3). A study by Jo et al. (29) revealed a beneficial correlation between observing nature through windows and the restoration of attention. Kaplan (30) conducted two distinct experiments comparing the existence of natural window views against their lack. Workers who had access to natural views reported a lower incidence of common health conditions during the previous 6-month period and experienced greater levels of job satisfaction. The second study found that natural views were positively correlated with heightened emotions of privacy and happiness. Additionally, natural views were linked to reduced frustration and enhanced levels of patience and enthusiasm towards tasks. Plasma televisions that simulate window views do not have the same rejuvenating effects (31). Workers who do not have access to actual windows are more inclined to bring in plants and natural pictures to make up for the absence of an outdoor environment (32). A study conducted by Kaplan (33) shown that residential satisfaction and overall resident well-being were positively influenced by natural views. This conclusion was reached after polling inhabitants in six low-rise apartment complexes. In a similar vein, Tennessen and Cimprich (34) conducted a study on college residence halls to investigate the impact of window views on the restoration of directed attention. They tested students residing in three different residence halls and categorised them based on the sort of landscape visible from their room windows. The study revealed that individuals who had unobstructed views of natural scenery from their residence hall window demonstrated superior performance on two distinct objective assessments of focused attention. Additionally, these individuals subjectively reported a higher level of attentional concentration. Moreover, research indicates that natural landscapes hold subjective significance for both students and teachers. For example, Karmel (35) demonstrated that high school students in classes without windows were more inclined to include windows in their drawings of the school, as compared to students in classrooms with windows. Olivier (36) discovered that when kids are exposed to nature-based learning, teachers observe a favourable impact on their students, such as heightened engagement, willingness to take risks, enhanced enjoyment of school, and a stronger sense of responsibility towards their environment.

According to Becker, et al.(27), students who had a natural view of their surroundings gave higher ratings to the course curriculum, classroom resources, and classroom supplies compared to students who did not have a natural view. Further found that having a clear view of natural scenery is associated with more desirable psychological outcomes in college classrooms. According to Chavaly and Naachimuthu (37), there is potential to utilise naturebased therapies for the purpose of enhancing the mental well-being of the general public. Nine studies (38-45) have reported a significant decrease in stress and an increase in relaxation, both physiologically and psychologically. Researchers (38,40, 46, 47) have documented a reduction in depression, anxiety, tension, pain, and fatigue as notable enhancements in mental health for individuals. Majors (48), presented substantial evidence supporting the notion that being exposed to nature and its various components has a positive impact on one's overall state of well-being. Exposure to nature has consistently demonstrated a beneficial correlation across various areas, such as work productivity, interpersonal connections, and scholastic achievement. Outdoor natural habitats offer health advantages by alleviating stress, rejuvenating cognitive exhaustion, enhancing mood, and promoting mental wellbeing. Yusli et al. (49) found that views of nature through windows can influence the three aspects of attention restoration theory (ART), specifically, the sense of being away, curiosity, and compatibility, as well as psychological well-being. Further, indicated that it is not necessary to exclusively observe actual natural environments in order to have beneficial psychological effects. Alternatively, observing nature from a window can also have a positive impact on one's mental well-being. Extensive research underscores the positive impact of observing peaceful natural surroundings on cognitive functions and physiological arousal. Window views of nature contribute significantly to





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attention restoration, job satisfaction, and overall well-being, as demonstrated by studies on workers and residential satisfaction. The presence of natural landscapes in educational settings enhances student engagement, risk-taking willingness, and enjoyment of learning. Moreover, the therapeutic potential of nature-based interventions is evident in numerous studies showing reductions in stress, anxiety, depression, tension, pain, and fatigue. The consistent findings across various domains, including work productivity, interpersonal connections, and scholastic achievement, affirm the overarching influence of nature exposure on human well-being. Studies emphasizes that even observing nature through windows can positively impact mental well-being, highlighting the versatility of nature's psychological benefits.

Impact on attention

Attention is a crucial asset in fostering student involvement (50). Exposure to nature, even in small amounts such as looking at trees from a window or taking a walk in a park, has beneficial impacts on attention and working memory(21). The Attention Restoration Theory (ART) explains how nature positively impacts mental processes and cognitive function. According to this idea, sustained mental exertion can cause directed attention to become exhausted, resulting in irritation and decreased cognitive performance (51). Natural environments are restorative because they offer a chance to escape, captivate our attention readily, create a feeling of spaciousness, and align well with human tendencies (30). Hartig et al., (52) found that university students' directed-attention abilities improved when they walked in nature or viewed photos of nature, as measured by tasks. Research has shown that green areas help reduce stress and revitalise university students experiencing mental exhaustion (53-55). Studies have shown that exposure to natural areas can lead to improvements in attention, in contrast to exposure to urban environments. The enhancements are observed in both young and old adults (56), those experiencing mental weariness, and youngsters diagnosed with ADHD (57). A research based on direct observation found that children, even those whose symptoms did not improve with medicine, exhibited clear behavioral improvement in outside environments. Poor indoor temperature can decrease comfort levels and has been linked to decreased attention, vigilance, study performance, and other health issues like weariness, headaches, and irritation of eyes, nose, and throat, as well as nausea among teachers and students (46, 58-63). In a restorative setting, an individual's focused attention, which is a valuable tool for learning, is maintained and replenished, especially when it has been depleted by earlier stressful experiences (64).

This research confirmed the findings of Raanaas et al., (65) by demonstrating that individuals who have dormitory windows with natural views are more proficient in directing their attention compared to those with fewer natural views (49). Attention plays a crucial role in student engagement, and being exposed to nature, even in simple ways such as looking at trees from a window or going for a walk in a park, greatly improves attention and working memory. The ART explains how natural environments have a good impact on mental processes by offering an opportunity to escape, capturing attention, establishing a feeling of openness, and harmonizing with human inclinations. Studies suggest that green spaces have a significant impact in reducing stress and rejuvenating university students who are experiencing mental fatigue. Furthermore, being in natural environments has been shown to enhance attention abilities in persons of different age groups and circumstances, such as young and elderly adults, individuals suffering from mental fatigue, and youngsters diagnosed with ADHD. The significance of environmental elements, such as inadequate indoor temperature, is emphasized, as they might affect the ability to concentrate, maintain alertness, and overall state of health among students and teachers. The results emphasize the rejuvenating effect of natural scenery in maintaining and restoring concentrated attention, especially following stressful situations.

Impact of indoor natural elements

Research has shown that people generally perceive natural environments as more soothing, tranquil, and pleasant (66, 67). Akande et al., (68) indicated that the majority of users expressed satisfaction with patterns derived from nature in space patterns and natural analog patterns that are associated with both direct and indirect connections to natural systems. Indoor natural elements like plants and green walls can raise humidity levels and lower temperature, carbon dioxide levels, and volatile organic compounds (67, 69-72). Students who attended a lecture in classrooms containing potted plants or flowers reported higher levels of attention, more favourable evaluations of the





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lecture, and a more positive perception of the classroom atmosphere compared to those in the control classroom. According to Schauer et al., (73) the natural elements readily captivated the senses and effortlessly focused attention on the present time. The focus on nature's enigmatic, exquisite, and awe-inspiring aspects not only enhances one's vitality but also brings one into the present moment by evoking a sense of wonder. A meta-analysis investigating the impact of natural surroundings on cognitive capacity has substantiated that exposure to nature has the most significant influence on working memory out of the eight cognitive domains (74). In their study, Lirong et al. (21) found that visualscape, smellscape, and haptiscape had a significant impact on attention restoration. On the other hand, soundscape influenced attention restoration indirectly by eliciting favourable feelings. Biophilic design patterns offer an interactive and sustainable alternative to current techniques in sustainable design skill development (68). Leather et., al., (75) indicated a substantial and direct impact of sunshine penetration on work satisfaction, intention to resign, and general well-being. The presence of natural features such as trees, vegetation, plants, and leaves was discovered to mitigate the adverse effects of job stress on the desire to quit, and also had a slight but noticeable impact on overall well-being. Studies continually demonstrate that natural settings are universally regarded as calming and enjoyable. Introducing natural components like as plants and green walls indoors can have a beneficial effect on humidity, temperature, and air quality. Students who attended lectures in classrooms that had plants reported increased levels of concentration, more positive evaluations, and an impression of a nice ambiance. A meta-analysis highlighted the substantial impact of nature on working memory, while also noting the combined influence of visual, olfactory, and tactile stimuli, as well as the indirect effect of auditory stimuli, in promoting attention restoration. Biophilic design is a method of developing design skills that is participatory and sustainable. It has a good impact on work satisfaction and overall well-being.

Influence of nature walk

Walking is a widely shared activity across various types of outdoor enjoyment. The forest serves as a natural resource that offers urban residents the opportunity to engage in the popular leisure activity of walking in a natural environment (11). The nature walk was characterized as a more invigorating, stimulating, rejuvenating, and intellectually enriching setting compared to the urban walk (76). Bratman et al., (77) conducted a study to examine the influence of exposure to nature on emotions and cognitive processes. A total of sixty participants were randomised at random to either a 50-minute walk in a natural area or an urban environment in and around Stanford, California. Participants conducted a number of psychological tests of affective and cognitive performance both before and after their walk. The nature walk yielded both affective benefits, such as reduced anxiety, rumination, and negative affect, and preservation of positive affect, as well as cognitive benefits, such as improved working memory performance, as compared to the urban walk. Chou et al., (11) indicate that regularly engaging in 30-minute forest walks once a week for eight consecutive weeks has several positive effects. These include improvements in mental health, increased engagement in learning at school, enhanced ability to recover and reflect, and a stronger connection with nature. Engaging in brisk walking for a total of three hours each week, or around thirty minutes each day, is linked to a significant reduction of 30 to 40 percent in the likelihood of developing heart disease among women (78). Older visitors to local parks have claimed that stress reduction is a significant advantage (79). According to a study conducted by More and Payne in 1978, spending time in a park has been found to reduce negative moods and result in decreased levels of anxiety and sadness among park visitors.

According to Zhang, et al., (80), those who engaged in activities such as walking in nature or looking at pictures of natural landscapes experienced higher levels of vitality compared to those who did not have exposure to nature. He et al., (81) demonstrated that guided forest therapy yielded favorable physiological and psychological outcomes for college students nearing graduation. Moreover, ladies experienced greater physiological advantages than males, whereas males experienced greater psychological benefits than females during forest therapy. Engaging in a leisurely walk through a natural setting, particularly a forest, is linked to revitalizing, inspiring, and cognitively enhancing encounters in contrast to walks in urban areas. Research indicates that engaging in nature walks has been found to result in decreased levels of anxiety, rumination, and negative emotions, while also enhancing working memory ability. Consistent participation in forest walks has been shown to have beneficial impacts on mental well-being, academic involvement, introspective skills, and a deeper affinity for the natural world. In addition, engaging in brisk





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walking has been found to be strongly associated with a notable decrease in the probability of getting heart disease. Similarly, visiting parks has been shown to contribute to the alleviation of stress and the enhancement of moods. Interacting with nature, whether by walking or looking at it, regularly results in increased energy and positive physiological and psychological effects.

CONCLUSION

According to teachers, educational pedagogies often include a significant amount of time dedicated to bureaucratic tasks and organizational efforts, particularly when working with new stakeholders, such as community members (82). Teachers must often take on the responsibility of designing curriculum and instructional resources (83). This comprehensive review emphasizes the profound positive impact of nature on various aspects of human well-being and cognitive function. The rejuvenating effects of outdoor nature-based learning, exposure to nature through window views, and integration of indoor natural elements contribute significantly to attention restoration, job satisfaction, and overall mental health. Engaging in nature walks, especially in forest settings, emerges as a powerful strategy for reducing anxiety, enhancing cognitive performance, and promoting overall physiological and psychological well-being. The findings underscore the importance of incorporating nature-based interventions into educational settings and workplaces, recognizing the versatile benefits that range from improved academic engagement to stress reduction. Whether through direct observation, window views, or physical interaction, the consistent evidence highlights the multifaceted advantages of connecting with nature for individuals across diverse age groups and circumstances.

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RESEARCH ARTICLE

Comparative Studies of Vermicompost Produced from Cattle Dung and **Paper Waste Employing Earthworms Varieties**

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ABSTRACT

Vermicomposting technology is one of the more economic, farmer's friendly waste management technology and resulting in the bioconversion waste to wealth. The main objective of this study was to assess the performance of various species of earthworm viz., P. excavatus, E. eugeniae and E. foetida with substrate vermicomposting. The present study was taken to investigate the vermicomposting of two different organic wastes like as paper waste and cattle dung waste with prepared vermicompost and using different types of earthworms. The treatment was designed as T1 Control, T2 Cattle dung with Eisenia foetida, T3 Cattle dung with Eudrilus eugeniae, T4 Cattle dung with Perionyx excavates and T5 Control, T6 paper waste with Eisenia foetida, T7 paper waste with Eudrilus eugeniae, T8 paper waste with Perionyx excavates. Wastes were mixed in the ratio of 40% of cow dung and 60% paper waste and cattle dung. In this study, development execution of worms and physico-chemical characteristics of vermicompost were analyzed with the time of period of vermicomposting for 90 days. The worm Eisenia foetida (T6) showed better growth performance during the process of composting in both substrates. The pH of vermicompost went optimum ranging from 7 to 8 as well as other physical parameter levels during the process of vermicomposting. The levels of significant supplements were recorded in increasing order while levels of organic carbon and C:N ratio recorded in decreasing order across various intervals irrespective of the treatments. In the T6 treatment of vermicompost using Eisenia foetida showed the highest concentrations of nitrogen (1.78±0.05), potassium (1.09±0.03) and calcium (1.06 ±0.08) with highest





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C:N ratio (13.4 and 13.5). This study clearly indicated that the vermicomposting is a suitable technology for bioconversion of paper waste and cattle dung into valuable materials. This study suggested that the *Eisenia foetida* could be used efficiently to manage wastes and good quality vermicompost.

Keywords: Vermicomposting, *Eisenia foetida, Eudrilus eugeniae, Perionyx excavates*, Electrical conductivity (EC), Paper waste and Cattle dung.

INTRODUCTION

India produces about 3000 million metric tons of organic wastes annually which are disposed of by ocean dumping, incineration and land application. Waste from domestic, agriculture, urban and industrial sources are the main cause of organic soil population. The Process vermiculture farming involves utilization of earthworms (natural versatile bioreactors) to cleaning up the environment with cost effective waste management technology for sustainable agriculture (also known as worm farming) (Kaviraj and sharma, 2003). Vermicompost, a by-product of earthworm mediated organic waste re-cycling, which is the rich in nutrients and possess growth promoting substances (biofertilizers) (Giraddi, 2001). Huge amount of solid waste are generated by agricultural, domestic and industrial activities which add to contamination, environmental change and eventually upset ecological balance (Lim and Wu, 2016). Vermicomposting is a biological process involving interactions between earthworms and microorganisms which efficiency convert different type of organic wastes into nutrient rich manure (Pigatin et al., 2016; Amouei et al., 2017). The subsequent vermicompost has been shown to have several positive impacts on plant development and health. Earthworm species convert this waste into better end product and provided solution to the problem of the organic wastes degradation (Nagavallemma et al., 2006). The significance of the earthworms in waste management, environmental conservation, organic farming and sustainable agriculture has been featured by a few specialists (Senapati,1992; Bhawalkar,1993; Ghatnekar et al.,1998; Talashikar and Powar, 1998). The paper waste and cow dung are non-toxic biodegradable wastes. House hold waste contains significant fraction of paper waste in the form of soiled newspaper, magazines, books, etc, which disposed unscientifically in the landfills. Due to poor collection and segregation practices recuperation pace of paper waste is only 19% out of the total paper utilization in India (Arumugam et al., 2015). In recent years, vermicomposting as an eco-friendly and economically viable technology for decomposition of organic waste resources into odour-free humus -like materials has been verified in literatures (Suthar, 2009; Garg et al., 2012; Sudkolai and Nourbakhsh, 2017). The main aim of this study is to be planned to evaluate the vermicomposting quality from two different waste mixture including newspaper and cattle dung waste mixed with and cow dung in the ratio of 60% and 40%. Compost with these microbes may reflect in better results compared to organic manure alone.

MATERIALS AND METHODS

Organic substrate and preparation

The waste was collected in and around Sundarakkottai, Mannargudi, Thiruvarur District, Tamil Nadu.Selected substrate namely paper waste and cattle dung. The cattle dung (10 days old) was procured from the nearby dairy farm. The moisture content was maintained at about 70-80% and the paper waste procured from the S.T.E.T. Women's College (Autonomous), Sundarakkottai, Mannargudi. The obtained paper was destroyed before using by means of a paper shredder.

Collection of earthworms

For the vermicompost treatments the earthworms of the *Eisenia foetida, Eudrilus eugeniae* and *Perionyx excavates* were procured from Periyar Maniyammai University Thanjavur.





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Experimental Setup

Vermicompost was conducted in eight set of experiments such as T1 Control, T2 cattle dung with *Eisenia foetida*, T3 cattle dung with *Eudrilus eugeniae*, T4 cattle dung with *Perionyx excavates* and T5 Control, T6 paper waste with *Eisenia foetida*, T7 paper waste with *Eudrilus eugeniae* and T8 paper waste with *Perionyx excavates*. Waste substrates were prepared in the ratio of 40% Cow dung and 60% waste substrate.

Preparation of composting bed

The vermicomposting was carried out in concrete cylindrical pits of 2 X 2 feet. The pit had proper aeration of minimum 1 cubic feet in volume. Trays of proper dimensions were kept below the pit to collect the drained water from pit. A green shade net was used to prevent the escape of earthworms from the pit and to avoid predators from harming the earthworms.

Addition of earthworms

500 grams of Epigeic species of earthworms *Eisenia foetida, Eudrilus eugeniae* and *Perionyx excavates* were added to the pit. Earthworms are omnipresent in a world-wide distribution. It has good temperature resistance and can live in organic wastes with various moisture contents. The different wastes and earthworms were mixed at an interval of two days. Water was sprinkled on the top layer to ensure proper moisture.

Following precautions were taken during vermicomposting

Vermicompost pit was protected from direct sunlight. The moisture level was maintained well in the pit for good compost formation. Pests were avoided which might harm the earthworms. The pit was well covered to avoid the earthworms from escaping the pit. Sufficient aeration was provided by proper stirring of the waste to get rid of foul odour. A proper shed was built around the pit so that rain water doesn't enter the pit.

Recovery of vermicompost

The processes of vermicomposting were carried out for a period of 90 days. The temperature of 30°C and 80% moisture content were maintained by sprinkling adequate quantity of water at frequent intervals. Vermicompost was obtained after 90 days of incubation. After preparation of vermicompost, water was not added for 5 days to make the compost easy for shifting. The compost was collected in a separate container so that the earthworms settled at the bottom were reused for next batch of vermicomposting.

Extraction of vermiwash

During the method involved with vermicomposting, drained water was collected as vermiwash which was utilized for additional screening. The vermiwash was collected in trays and transferred into sterile glass bottles and stored in refrigerator at 4°C (Aruna *et.al.*, 2006).

Physiochemical analysis of vermicompost

All physiochemical parameters were measured before and after treatment. Physical parameters such as pH, color, smell, electrical conductivity (EC), temperature and moisture of vermicompost and chemical parameters such as concentrations of Organic Carbon (Walkley and Black method), Nitrogen (Micro Kjeldahl), Phosphorus (Olsen method), Potassium (Flame photometry) (Piper, 1996; Jackson,1973; Ishwaran and Marwaha,1980) calcium, magnesium (Walkley and Black method) and heavy metals namely Zinc, Copper, Iron (Atomic Absorption Spectrophotometer [AAS]) and C:N ratio.

Packaging and stored of vermicompost

The vermicompost obtained was brownish-black color having a pleasant earthy smell. The prepared vermicompost was packed in polythene bags and stored.





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Study of micro flora from vermicompost

This vermiwash was filtered using a muslin cloth to remove solid particles. The filtered vermiwash was then serially diluted with sterile phosphate buffered saline (pH 7.2) and dilutions used for primary screening were 10^{-1} , 10^{-2} , 10^{-3} , 10^{-4} , 10^{-5} and 10^{-6} . From each dilution 0.1 ml was surface spread on sterile media such as Nutrient agar (for total bacterial count), Congo Red Yeast Extract Mannitol Agar (for detection of Rhizobium) and Ashby's Mannitol agar (for detection of Azotobacter) and incubated at 300 C for 24 hrs. All the media were prepared using Hi Media manual (1998). Colonies on Nutrient agar were counted and cfu/ml was calculated.

Identification of the micro flora

Identification was carried out on the basis of morphological, cultural and biochemical properties using Bergey's Manual of Bacteriology 8th Edition (1974). Identifications of bacteria such as Gram staining (Han's Christian Gram, 1959), Motility (Bailey and Scott, 1966), Biochemical characteristics was done by (Norris and Ribbons, 1972) such as Indole, Methyl red, Voges–proskuer (VP), Citrate Utilization, Catalase, Oxidase, Triple Sugar Iron Test and identification of fungi such as Lactophenol cotton blue technique (Gillman, 1975).

Statistical analysis

The reported results are the mean of three replicates with standard deviation (mean \pm SD). The probability levels used for statistical significance were <0.05 for the tests. Statistical analysis of the data was carried out with the SPSS 16.0 software programme.

RESULTS AND DISCUSSION

The agricultural waste and domestic waste was collected namely paper waste and cattle dung. The performance and productivity of *Eisenia foetida, Eudrilus eugeniae* and *Perionyx excavates* by using different substrates were assessed. Two different waste mixtures mixed with and cow dung in the ratio of 60% and 40%. In our work, the period of vermicomposting using wastes was found to be completed in the 90 days (Table 1). Vermicomposting is a process that involves chemical and physical transformation of agricultural residues of plant and animal origin through the use of worms and microorganisms (Garg and Gupta, 2009). Composting involves a wide variety of physical and chemical alterations of the nutrients. Recycling of waste and residues by utilizing fertilizer worm increases available supplement content of substrates (Theunissen *et al.*, 2010). Probably due to these reason, nutritional quality of enriched paper waste vermicompost was found to be rich than the normal vermicompost. The technical feasibility study of adopting vermicomposting was conducted to convert organic waste to bio fertilizer. The initial (before composting) final (after composting) stage of vermicompost was subjected to physical (pH, Temperature, Moisture, Color, Smell, and EC) chemical (macro and micro nutrients) and microbial load. The various parameters studied during the period using three species belonging to different substrate categories. All the species showed different potential for the reduction of organic materials used.

PHYSICAL PARAMETERS

The pH, moisture, temperature, color, smell and Electrical conductivity (EC) in vermicompost was analyzed of the duration 90 days. The pH was varied during the vermicomposting process. In the treatments pH level was varied in the duration of 90 days was a recorded in the treatments of T1-T8. Overall treatments the pH was low in the T3 and T7 and high inT6. The increased water holding capacity and moisture content treated with 70-85% values respectively. It has also noticed in mixture of vermicompost. The temperature of the substrate was high at the initial stage of the experiment. In thermopilic stages, the temperature was raised and it was gradually decreased in T6 (30.5°C). The maximum electrical conductivity of was observed in T6 (0.83±0.05) than control of vermicompost. All the treated vermicompost was showed earthy smell (Table.2).





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CHEMICAL PARAMETERS

Macronutrients

The organic carbon content (C), nitrogen (N), phosphorus (P), Potassium (K), calcium (Ca) and magnesium (Mg) content was estimated in all the treatments were recorded. Over all treatment the total organic carbon was decreased by T6 (12.85±0.01). Low carbon level is essential for the plant growth. Due to that T6 paper waste with *Eisenia foetida* was showed low carbon level. Hence, it is subjected to plant growth treatment. During the vermicomposting is because of the nitrogen content is delivered by earthworms metabolic products and dead tissues. The high content of nitrogen was found in T6 (1.78±0.05) using *Eisenia foetida*. The mineralization of total phosphorus level was increased by T6 (1.29±0.06). So the worms during vermicomposting converted the insoluble forms with the help of P-solubilizing microorganisms. High content of potassium (1.09±0.03), calcium (1.06±0.08), Magnesium (1.85±0.02) was recorded in the T6 treatment followed by T7, T2 and T5 (Table.2).

Micronutrients

The heavy metals namely Zinc, copper and iron were analyzed. Zn is essential for the transformation of carbohydrates and it regulated the consumption of sugars. So, the soil pH is the most important factor controlling the Zn availability (1.05±0.05). The higher levels of copper contents in T6 (1.08±0.03). Because of the vermicompost might be due to the presence of copper containing oxidizing enzymes. The presence of enzymes and co-factors in the earthworms get increased the iron content (1.48±0.03) the vermicompost (Table 2).

Isolation and identification of microorganisms

Serial dilution technique was used to isolate the bacteria and fungi from vermicompost. Bacteria and fungi were isolated from vermicompost after 90 days of composting process. The isolated bacterial colonies from vermicompost are identified as *Pseudomonas aerogenosa, Bacillus subtilis, Bacillus cereus and Enterobacter aerogens,* Phosphate solubilizing microorganisms and *Streptomyces*. Fungal species found in vermicompost are *Aspergillus niger, penicillium, Mucor, Rhizopus and Trichoderma spp* (Uma Maheswari and Ilakkiya., 2015). From our result clearly highlighted that vermicompost production from T6 using *Eisenia foetida* showed better performance rather than other treatment and vermiwash. In that treatment significant increase in the micro, macronutrients and microbial load and other aspects. Exotic species *Eisenia foetida* was more efficient in bioconversion of domestic wastes into nutrient rich vermicompost compared to *Eudrilus eugeniae and Perionyx excavates*.

CONCLUSION

In present study provided an attempt has been made to the vermicomposting of newspaper and cattle dung. The physicochemical analysis of the vermicompost produced by a fore mentioned substrates at different percentage pointed to the feasibility of the process. Vermicomposting is a natural process which not only gives a solution for waste management but also provides with nutrient rich compost. Vermicompost increases soil fertility as it consists of nutrients like Phosphorus, Nitrogen, carbon, zinc, copper, manganese, iron etc. Earthworm numbers wastes increased initially up to 90 days but after that a decline was observed that may be due to exhaustion of feed. This study clearly indicated that the vermicomposting is a suitable technology for bioconversion of paper waste and cattle dung into valuable materials. This study recommends that the *Eisenia foetida* could be utilized proficiently to make extraordinary quality vermicompost. This is an eco-friendly and cost effective method. Finally that vermicomposting can be used for management of institution paper wastes, and cattle dung management. These characteristics make vermicompost useful and effective in sustainable agriculture.





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Table.1 Details of Earthworm numbers in the composting periods

S. No	Name of the second	Forthern North	Earthworms numbers		
	Name of the waste	Earthworms Name	0 days	90 days	
1.	Cattle dung	F		87	
	Paper waste	Eisenia foetida	50	90	
2.	Cattle dung	F. Juil.	FO	83	
	Paper waste	Eudrilus eugeniae	50	86	
3.	Cattle dung			78	
	Paper waste	Perionyx excavates.	50	82	

Table.2 Details of Physico-chemical parameters status of vermicompost by using organic wastes.

S.N o	Parameters	Cattle dung Vermicompost				Paper waste Vermicompost			
		T1	T2	Т3	T4	Т5	Т6	T7	Т8
1.	рН	7.2	7.2	6.8	7	7.2	7.2	6.8	7
2.	Moisture (%)	70-81	70-81.5	70-80	70-81	70-80	70-82	70-81	70-81
3.	Temperatu re (°C)	30.5	30.5	31.5	32	30.5	30.5	31.5	32
4.	Color	Brownis h-black	Brownis h-black	Brownis h-black	Brownis h-black	Brownis h-black	Brownis h-black	Brownis h-black	Brownis h-black
5.	Smell	Earthy smell	Earthy smell	Earthy smell	Earthy smell	Earthy smell	Earthy smell	Earthy smell	Earthy smell
6.	Electrical conductivit y	0.49±0.01	0.79±0.05	0.80±0.03	0.79±0.02	0.44±0.08	0.83±0.05	0.63±0.08	0.72±0.04
7.	Organic Carbon (%)	12.33±0.2 3	12.85±0.0 1	12.01±0.8 3	11.08±0.1 5	12.33±0.2 3	12.35±0.0 1	12.31±0.0 1	11.85±0.0 6
8.	Nitrogen (%)	1.63±0.07	1.73±0.07	1.70±0.08	1.69±0.05	1.63±0.07	1.78±0.05	1.72±0.06	1.68±0.03





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9.	Total phosphoru s (%)	1.21±0.06	1.30±0.06	1.28±005	1.26±0.03	1.27±0.03	1.29±0.06	1.24±0.02	1.22±0.03
10.	Potassium (%)	0.97±0.09	1.08±0.01	1.05±0.02	1.06±0.03	0.93±0.06	1.09±0.03	1.05±0.04	1.03±0.02
11.	Calcium (%)	0.96±0.03	1.05±0.08	1.05±0.06	1.04±003	0.96±0.03	1.06±0.08	1.02±0.05	0.98±0.06
12.	Magnesium (%)	1.56±0.06	1.82±0.01	1.68±0.04	1.63±0.03	1.52±0.03	1.85±0.02	1.76±0.04	1.80±0.06
13.	Zinc (%)	0.98±0.02	1.04±0.05	1.03±0.03	1.01±0.02	0.98±0.03	1.05±0.05	1.03±0.10	1.02±0.08
14.	Copper (%)	0.96±0.07	1.07±0.03	1.04±0.06	1.03±0.04	0.94±0.06	1.08±0.04	1.05±0.06	1.02±0.03
15.	Iron (%)	1.34±0.04	1.46±0.01	1.41±0.06	1.35±0.02	1.34±0.06	1.48±0.03	1.27±0.05	1.18±0.07
16.	C/N	12:1	13:4	13:3	13:2	12:1	13:5	13:2	13:1





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RESEARCH ARTICLE

Use of Differential Equations for Modelling Cancer Cell Growth

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ABSTRACT

The research work presents a study on the effectiveness of the use of differential equations in modelling cancer growth. The research determines that there exist numerous differential equations that models growth and progression of differential equations, but they often omit essential progression parameters associated with the disease's prognosis. The research work concludes that if efficient differential equation modelling of cancer growth is to be performed inclusion of essential parameters such as cell interactive effects and therapeutic effects should be included in the model along with its cross validation through real world cancer growth data.

Keywords: The research determines that there exist numerous differential equations that models growth and progression of differential equations, but they often omit essential progression parameters associated with the disease's prognosis.

INTRODUCTION

Cancer is a leading cause of death in India and across the world. The disease is the second leading cause of in the world and 4th in India. In India Cardiovascular diseases takes the first podium in terms of cause of death, respiratory diseases steps on second, while tuberculosis steps on third. Cancer appears on fourth platform. In India on a yearly basis cancer contributes to 9.4 percent of deaths. Medical science has attained the cure of cancer. Number of cancer survivors are increasing day by day, but the prognosis of disease is still not very effective. Cancer still needs tremendous research work especially in field of effective early identification. Even if identified early how the cancer progress is still a field of research in modern medical science. The cure for the cancer is known. Surgery,





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immunotherapy, chemotherapy, and radiation therapy have presented their efficacy in successful treatment of cancer. However, the treatment outcomes are not always positive. It depends upon number of factors such as degree of tumor, time of detection, implementation of treatment schemes, and body's auto immune response. Mathematical models have been developed that predicts the time of treatment and the quantity of drug required to treat the cancer. The cure of cancer is costly. Treatment involves use of costly imaging techniques, medicines, consultation, and radiation therapy. Every step requires use of costly technology. In India the disease is spreading fast. The disease is not only genetically linked but has also become a part of lifestyle disease segment. To identify cancer growth, its cancer imaging is required. Cancer imaging requires exposing the patient to the radiations. This exposure to radiation results in imaging of the tumor. Repeated exposure to radiation is not possible as it can further result in cell mutation and damage of existing healthy cells. Further, interval between two successive imaging requires a cooling period which can range from fifty to ninety days. Imaging is also a costly process. A full body MRI requires 15 to 20 thousand rupees. Apart of being costly MRI presents result of tumor progress at the time of detection and period after subsequent intervention. The disease is a complex mechanism. At times it progresses rapidly even after intervention. Therefore, a overcome such complexities it is essential to model the tumor progression. Differential equations present a promising success in this field. Differential equations help in —

- 1. Identifying growth dynamics of tumor cells.
- 2. Spread of cancer cells.
- 3. To optimally control chemotherapy.
- 4. To understand work of chemotherapy in reducing tumor cell volume.

Study of Modelling Techniques

At present there exists numerous differential equation cancer modelling techniques. Each techniques have its own added advantage and shortcomings. The research work presents study of existing literature that deals with modelling of cancer progression through differential equation and will identify the technique that is frequently utilized in this study area. (Trisilowati, 2012) in her research work incorporated the immune component, dendritic cell therapy, cytotoxic T cell effect, lymphocyte effect, helper T Cell effect, CD4+ and CD8+ effects on ODE for prediction of tumor growth. The research work utilized the Runge-Kutta method for determining the solution of differential equation.

Use of this Method

The work adopts Runge-Kutta Method for solving differential equation. The method is one of the best suited ones when it comes to solving problems that require temporal discretization. In other words, the method is one of the best suited ones for simulation of a complex problem such as cancer cell progression.

(Endeling and Chaplain, 2014) in their research work focused on analysing the tumor growth through ordinary differential equation and how it shrinks under the treatment. The research work utilized the Gompertz differential equation and incorporated the anti-tumor treatment and the anti-angiogenic treatment component in it. With the help of a graph the research work indicated a fast exponential decaying tumor size with time with the introduction of tumor treatment.

$$\dot{V} = aV \ln \frac{b}{(V+C)}$$

V is the volume of the tumor and \dot{V} is its progression

a, b, and c are the constant coefficient defining the growth model.

Use of this Method

The Gompertz differential equation is well known to model biological processes. The equation is easy to use and results in faster simulations. However, the method is infested with drawbacks such as non-inclusion of important parameter 'time of infection'. Researchers have improved upon the model. But the improved model is case wise and is tailor fitted to individuals' simulation processes. Despite model lacking important parameters it has been used extensively for cancer modelling. Once such case is presented by (Vaghi and Ebos, 2019). They focused on Population modeling of tumor growth curves and the reduced Gompertz model improve prediction of the age of experimental





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tumors. The reduced Gompertz model was found to exhibit the best results, with drastic improvements when using Bayesian inference as compared to likelihood maximization alone, for both accuracy and precision. Specifically, mean accuracy (prediction error) was 12.2% versus 78% and mean precision (width of the 95% prediction interval) was 15.6 days versus 210 days, for the breast cancer cell line. These results demonstrate the superior predictive power of the reduced Gompertz model, especially when combined with Bayesian estimation. Examples of improved Gompertz model are also present. One such case was presented by (Yin, Moes, Hasselt, Swen, Guchelaar, 2019). In their research focused on the review of different ordinary differential equation used for determination of tumor dynamics. The research work stated that Linear growth, exponential growth, logistic growth, Gompertz growth and the combination of exponential and linear growth are basic functions that describes natural tumor growth. The Tumor burden model is helpful in integrating tumor heterogeneity. The research work indicated that immune system model helps in understanding the interaction of tumor dynamics with immune system responses. The research work also indicated the non-linear drug exposure relationship. Modelling of cancer cell requires involvement of multiple parameters. Such as effect of T-cells, immune systems, and interaction between healthy and cancer cells. This multiparameter model when includes the use of chemotherapy in it results in efficient modelling of cancer progression one such case was demonstrated by (Abernathy, Abernathy, and Stevens, 2020). In their research work focused on developing a mathematical model for determination of tumor growth. They focused on how tumor growth and shrinks before and after the introduction of virotherapy. The research work with the help of Hopf bifurcation differential equation presents the interaction between the tumor cells, uninfected tumor cells, virions, and effector T-Cells. Such differential equations could be modelled as -

For modelling of effects of therapeutics on cancer the following differential equation would be used.

$$\begin{split} N'(t) &= aN(t) \big(1 - bN(t) \big) - \alpha_1 N(t) T(t) - k_N u(t) N(t) \\ L'(t) &= rN(t) T(t) - \mu L(t) - \beta_1 L(t) T(t) - k_L u(t) L(t) \\ T'(t) &= cT(t) (1 - dT(t)) - \alpha_2 N(t) T(t) - \beta_2 L(t) T(t) - k_T u(t) T(t) \\ u'(t) &= v - \omega u(t) \end{split}$$

The model variables are T(t) for tumor cell population at time t, N(t) for NK cell population, L(t) for cytotoxic T cell (CTLs) population, and u(t) for quantity of drug at the tumor site.

Example of inclusion of therapeutics in differential model was also presented by (Sharpe and Dobrovolny, 2021). In their research work used the ordinary differential equation to predict the effectiveness of the chemotherapy. The research work in their ODE incorporated the stochastic process. The research work utilized ten different ODE to simulate the tumor growth and effect of chemotherapy in reducing the tumor growth to a level of being classified as cured. The stochastic process incorporation changed the level of chemotherapy and time needed to cure the tumor. Cancer modelling through differential equation is only possible when the growth and progression data points are available with the researcher. To determine the same Xenografting techniques are available.

Benefit of Xenografting

Human trials is not possible when it comes to repeated recording of cancer cell progression. Therefore, human xenograft trials on nude mice open dimensions of cancer cell progression measurement. Efficient use of xenograft models was exhibited by (Varna, Bertheau, and Legres, 2014). In their research work focused on generation of tumor growth data for research purpose. The researchers focused on generating the tumor growth data through xenografting of human tumor in nude mouse. The researchers stated that in nude mouse site specific engraftment is possible. Nude mice possess immune compromised systems which act as an excellent environment for studying human tumor growth.

CONCLUSION

The research work focused on determining the use of differential equation in modelling cancer progression. From the study the research work concludes that Gompertz model of modelling cancer growth is a convenient means to





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understand the cancer progression. However, the model lacks essential inclusion of critical parameters such as time of infection and effect of chemotherapy on the cancer cell progression. Effective modelling of cancer cell progression is possible only when the combined effect of immune system, chemotherapy, and cancer – healthy cell interaction is considered. Therefore, it is concluded that either the Gompertz model should be rectified to include the above stated parameters or existing differential equations such as Hopf bifurcation model be used those accounts for such parametric effects. Efficacy of differential equations can only be determined when tested upon the real-world examples. Therefore, it is concluded that the progression obtained through the developed model should always be tested against the real progression of infection. For the sample nude mice xenograft studies were found to be a helpful data assimilation source.

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RESEARCH ARTICLE

Budding Nutrients in the Leaves of Banana and Giloy for Diabetics **Evaluation**

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ABSTRACT

Diabetics is the chronic silent killer in the present generation .This diabetics can controls by the proper exercise, intake of good food and monitoring the levels of stress from time to time. The present study evaluates the minerals present in leaves of home yard plants banana and giloy. Under this study, the plants were selected from local areas of Hyderabad and verified by a botanist. Later, macerated to form liquid solutions. Under Atomic Absorption Spectroscopy technique trace minerals and their concentration is given out .Apart from it, data collected was tabulated and represented graphically. The minerals were cross checked with the already available literature for minerals that contribute to diabetes type 2 therapy Finally, this technique highlights the importance of minerals when taken as proper First Aid to mark Sustainable Eco lifestyle for Diabetic People.

Keywords: Minerals, Macerated, Botanist Atomic Absorption Spectroscopy, Home yard plant, Diabetic.

INTRODUCTION

Diabetes mellitus is a collection of disorders that impacts metabolism of human cycle. The primary care can be from physician who will be able to grasp the etiopathogenesis of mineral deficits and provide appropriate treatment options if they are detected early. But this way of approach is painful and hectic so, home yard gardening of





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medicinal plants helps us to control it for some point of time. As we know plants are factory of kitchen we can we get mineral levels needed for diabetic individuals and also monitored it as first aid. This chronic illness is a longterm condition of protein, lipid, and glucose metabolism [1, 2]. Type 1 and Type 2 diabetes are the two types of insulin production and secretion inefficiency. Underlying cause of diabetes differs depending on the kind. However, regardless of the type of diabetes you have, it can cause an excess of sugar in the blood. If Blood sugar levels that are too high can cause major health concerns. Breaking down the food we eat into multiple nutrient sources is part of the digestion process. When carbohydrates (such bread, rice) are eaten, the body converts them to sugar (glucose) which is nothing but insulin which enters the bloodstream. Glucose requires assistance to reach its eventual destination, which is inside the body's cells (which are the functional and structural units of tissues and organs). Insulin is a hormone produced by the pancreas and released into the bloodstream. It acts as the "key" that opens the "door" in the cell wall that permits glucose to enter the cells of the body. Glucose is the "fuel" or energy that tissues and organs require to function properly. Diabetes is caused by a lack of insulin or a failure of the insulin system [2]. A person with diabetes either has a pancreas that doesn't produce any/enough insulin, or a pancreas that produces insulin, but the body's cells don't respond to it and can't utilise it properly. Subsequently, glucose cannot enter the cells of the body and remains in the bloodstream, causing blood glucose levels to rise. According to data, this condition affects 2.8 percent of the world's population and is anticipated to rise to more than 5.4 percent by 2025. [3]. Diabetes is one of the top causes of death worldwide, with 1.6 million people dying from it in 2016. Diabetes increases one's chances of dying early by at least a factor of two, yet many parts of the world lack adequate treatment alternatives.

Southeast Asia had the largest number of diabetes deaths, with about 592,000 individuals dying from the condition in 2019. With around 116 million diabetics; China is the country with the biggest number of diabetics in the world. India is expected to have over 134 million diabetics by 2045, according to estimates, crossing China. Figure 1 show how the insulin resistivity is needed to pancreases to enhance the blood sugar levels. Diabetes necessitates early detection, treatment, and lifestyle modifications. Diabetes is the sixth greatest cause of death in the twenty-first century, affecting millions of people [4]. Diabetes has a high incidence, a complex path physiology, a progressive process, and consequences, all of which underscore the urgent need for better therapies. To control diabetes, many treatments such as insulin therapy, medication, and food therapy are now accessible. Several types of glucose-lowering medications exist, each with a different mechanism for anti-diabetic action. Sulfonylurea and meglitinide medicines stimulate insulin secretion, biguanides and thiazolidinediones increase peripheral glucose absorption [5], alphaglucosidase delays carbohydrate absorption from the colon, and biguanides reduce hepatic gluconeogenesis [6]. Despite substantial advances in the treatment of diabetes over the last three decades, the results of treatment in patients are still far from flawless. Drug resistance (lower efficacy), side effects, and even toxicity are some of the drawbacks of these treatments. Sulfonylureas, for example, decrease their effectiveness in 44 percent of patients after 6 years of treatment. It's also claimed that glucose-lowering medications can't regulate hyperlipidaemia [8].

Medical personnel nowadays have started evaluating the negative effects of diabetic drugs and their interactions with one another. Many treatments including the use of medicinal plants are now widely suggests [9] that the nutrients present in them enhances the blood sugar levels at quicker rate than drugs if used as the first aid when time needed. Herbal medicine has experienced exponential growth in recent years, and these treatments are gaining appeal in both developing and developed countries due to their natural origins and lack of negative effects .Medicinal plants, minerals, and organic matter are used in many traditional therapies [10]. Carotenoids, flavonoids, terpenoids, alkaloids, and glycosides are found in almost all plants of figure 2 shows potential of anti-diabetic properties [11]. Plant's anti-hyperglycaemic benefits are often attributable to their ability to increase the performance of pancreatic tissue, which is accomplished by raising insulin releases or limiting glucose absorption in the intestine. In herbal preparations of Indian traditional health care systems, a number of medicinal herbs known as Ramayana have been used for over 1000 years [12]. In Indian medicine, the majority of practitioners create and administer their own recipes [13]. The World Health Organization (WHO) has compiled a list of 21,000 medicinal plants used around the world. India has 2500 species, with 150 of them being used economically on a considerable basis. India is the world's largest producer of medicinal herbs and is known as the world's botanical garden [13]. The number of people living with diabetes is rising, raising worries among the medical establishment and the public. The





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current study focuses on herbal medicinal preparations and minerals content needed for diabetic care in spectroscopic way.

REVIEW OF LITERATURE

In a study done in 2016 by Kootiet al. the researchers concluded that since diabetes is caused mostly by oxidative stress and an increase in reactive oxygen species, both of which can have serious consequences, many plants including natural antioxidants, such as tannins, flavonoids, C and E vitamins, can help maintaining cell function and lower blood glucose levels [14]. They further added that medical plants are less expensive, have fewer side effects, and are more effective in the treatment of diabetes mellitus than manufactured pharmaceuticals. A study done by Manisha et al, in 2007, complied list of medicinal plants with anti-diabetic and other therapeutic benefits, as well as herbal medications used in diabetes therapy. Allium Sativum, Eugenia Jambolana, Momordica Charantia, Ocimum Sanctum, Phyllanthus Amarus, Pterocarpus Marsupium, Tinospora Cordifolia, Trigonella Foenum Graecum, Withaniasomnifera, Withaniasomnifera were the plants included among them [15]. In a study conducted by Chowdhury et al., in 2019, the researchers did a review of home yard medicinal plants commonly used in diabetic care and noted that garlic, onion, and fenugreek (curability rates of 48.57 percent, 60 percent, and 76.73 percent, respectively) are particularly helpful in maintaining hypoglycemia in diabetic and non-diabetic individuals. They further noted that due to its antibacterial and antidiabetic effects of blackberry, holy basil and aloevera culture on patients is an excellent source for home yard growing due to its chemical components. Eugenol, Linalool, Estragole, Limonene, Citral, Methylchavicol, And Methyl Cinnamate are some of these [16]. They further added that natural resources are being viewed as promising drug discovery possibilities, and they are playing an important part in drug development efforts. Furthermore, many therapeutic herbs are a gold mine for bioactive compounds with few unpleasant side effects and potent pharmacological benefits.

In 2018, a study was done by Moradi et al. on medicinal herbs to treat diabetes. According to the findings of this study, Trigonella Foenum-Graecum, Urtica, Allium Sativum, Ferulaassa- Foetida, Carthamus Tinctorius, Bauhinia, Swertia, Gymnemasylvestre, Combretum, Sarcopoterium, Caesalpinia Bonduc, Liriope, Coccinia Grandis, Mangifera Indica, Syzygiumcumini, Momordica Charantia, Pterocarpus, Ocimumtenuiflorum, Tinosporacordifoli, Panax, Cinnamomum Verum, Salvia Officinalis, Abelmoschus Moschatus, Fabaceae, Mentha, Vachellianilotica, Achyranthes, Asphodelaceae, , Artemisia Herba-Alba, Artemisia Dracunculus, Andrographis Paniculata L, Azadirachta Indica, Pachira Aquatic, Caesalpinioideae, Gongronemalatifolium, Tinospora Cordifolia (Guduchi), Nigella Sativa, , Chrysanthemum Morifolium, Symphytum, Cactaceae, Zingiber Zerumbet, Symplocos, Terminalia Chebula, Perilla Frutescensand Aloe Vera were sound effective in controlling and treating diabetes [17]. In a study done by Sonkar et al. to estimate the level of essential trace elements and its implications in type 2 diabetes mellitus patients it was found that compared to healthy people, T2 DM patients had considerably reduced levels of selenium, zinc, copper, and magnesium [19]. In an article titled "Trace elements in glucometabolic disorders: an update", Nicolas Wiernsperger noted that in diabetes, trace element supplementation (chromium, zinc, selenium, lithium and vanadium) is ineffective as a monotherapy, and it is even less effective in prediabetic conditions [20].

METHODOLOGY

The objective of this study is to ascertain the efficacy of two medicinal plants grown in home yard namely Banana and Giloy for diabetic care, by extracting and documenting minerals found in them by Spectroscopic technique.

Inclusion criteria and Exclusion criteria

Plants found in home yard and backed by literature are having anti diabetic action for correcting insulin levels. Plants not found easily in home yard or in populated areas and not backed by any literature in having anti diabetic action. The plants used in this study were selected from local places of Hyderabad. Two plants, namely Banana and





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Giloy were chosen based on the inclusion and exclusion criteria and because spectroscopicaly not much has been studied about them in the literature. The selected plants were authenticated by a botanist.

Extraction

The leaves of these plants were plucked off, cleaned and then dried under direct sunlight for 4-5 days to male them moisture free and dry. These dried leaves were then turned into powder. This powder then went through maceration process with menthol as solvent and stored in glass ware for further use. Maceration Process of Menthol Solution is used in this experimental process.

Spectroscopic Studies

AAS (Atomic absorption spectroscopic) technique of spectroscopy was used to check for the presence of elements/minerals.AAS is a technique for determining how much of a given element is present in a sample. It is based on the fact that atoms (and ions) can absorb light at only one wavelength. The energy (light) is absorbed by the atom when this precise wavelength of light is delivered. In the atom, electrons migrate from the ground state to the excited state. The amount of light absorbed is derived from the concentration of the element in the sample. Solution containing the analyte is injected into a flame. The flame turns samples into excitable free ground state atoms. A lamp generating light with a wavelength specific to the atoms is passed through the flame, and the electrons in the atoms are activated when the light energy is absorbed. The Beer Lambert law outlines the link between element concentration and light absorption. The amount of light absorbed is proportional to the number of atoms in the flame that have been stimulated from their ground state, according to the law. Results are obtained through the spectroscopy technique by getting separate peaks for separate wavelengths of different minerals found in the leaves (extract). Statistical interpretation of the minerals is done to quantify them in these plants and subsequently understand the importance of these minerals (in these plants) in diabetic care. Zinc, Copper, Iron, Magnesium, Manganese, Selenium, Vanadium, Chromium and Lead are the minerals that have been documented in literature to have the capability to increase and balance insulin levels and hence, sugar in the blood. These minerals, hence, are to be looked upon into these plants to ascertain their efficacy and efficiency in care of diabetes type 2 patients. If having the required minerals, these can be taken in raw form for regulating the blood sugar levels and insulin balance.

Statistical Analysis

The picturation highlights data about the minerals extracted and processed through AAS is tabulated and converted to bar-charts for better visual and graphical representation and ease of comparison.

DISCUSSION

Micronutrient deficiencies and the potential utility of supplementation play an important role in glucose metabolism and hence understanding their impact is important in the prevention and/or management of type 2 diabetes mellitus [21]. According to clinical and epidemiological studies, hypo magnesemia in diabetes is generally seen though the underlying processes for Mg shortage in diabetic patients are still unknown. In our study, in both banana and giloy leaves the concentration of Mg was found to be 28.586. Chromium is necessary for optimal carbohydrate metabolism and contributes to glucose homeostasis. In our study, in banana leaves the concentration was found to be 28.586. and while in giloy leaves it was found to be 28.385. Glucose intolerance, reduced insulin response, and enhanced glucose response are all symptoms of copper deficiency. Copper stimulates lipogenesis and has insulin-like properties. In our study, in banana leaves the concentration was found to be 28.586, while in giloy leaves it was found to be 28.585. Elevated Iron reserves can cause diabetes by a variety of processes, including oxidative damage to pancreatic cells, liver insulin extraction impairment, and insulin's capacity to control hepatic glucose synthesis. In our study, in banana leaves the concentration was found to be 28.586, while in giloy leaves it was found to be 28.585. The antioxidant property of selenium decreases the development of problems in diabetics. In our study, in banana leaves the concentration was found to be 25.586, while in giloy leaves it was found to be 24.585. Manganese activated enzymes play a crucial part in glucose, amino acid, and cholesterol metabolism, as well as appropriate insulin





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synthesis and secretion. In our study, in banana leaves the concentration was found to be 25.586, while in giloy leaves it was found to be 22.585.An increase in intracellular oxidants and free radicals, as well as a decrease in intracellular zinc and zinc-dependent antioxidant enzymes, may be linked to many of the consequences of diabetes. In our study, in banana leaves the concentration of Zn was found to be 28.586, while in giloy leaves it was found to be 28.585.By boosting the activity of glucose transporters via insulin receptor substrates 1 and 2 (IRS1/2) and phosphatidylinositol 3-kinase, the vanadium salt are found to trigger a mechanism to reduce hyperglycemia and improve insulin action. In our study, in banana leaves the concentration was found to be 28.586, while in giloy leaves it was found to be 28.58

RESULT AND CONCLUSION

This study helps us to investigate the anti-diabetic potential minerals of the home yard medicinal plants. The study was conducted in Hyderabad and plants selected from local areas. Banana and Giloy plants leaves taken were chosen for the same This AAS (Atomic absorption spectroscopic) technique of spectroscopy reveals the presence of Nickel, Gold, Silver, Mn, Mg, Se, Va, Zinc, Copper and many other minerals which helps the metabolism action of Blood sugar in the body either by Producing, Secreting and Enhancing the Insulin hormones at the quicker rate. Though, these minerals are harmful if intaken as a larger portion. The present study provides various resourceful information in relation to pharmacognostic identification of two leaves of giloy and banana. Furthermore, information regarding physicochemical characteristics of leaf and nature of chemical constituents present in them would also be useful for standardization of herbals and enrichment of Ayurvedic Pharmacopeia. TLC fingerprinting and GC-MS analysis could also help to identify and isolate important phyto-constituents. Thus, this type of study may give information on nature of active principles present in the medicinal plants and to identify the plants from their adulterants using isolated compounds as marker. These findings could be helpful in identification, authentication and standardization of medical plants and its methanolic extract. It would also help scientists to utilize such needful information regarding the plant material identity. The current research relates the relevant useful information on spectroscopic mineral identification in banana and giloy leaves (home yard plants).

In addition, information on the ingredients found in them would be beneficial for standardising herbal medication material. Additionally, utilising isolated chemicals as markers, this type of investigation may provide information on the nature of active principles contained in medicinal plants, as well as identify the plants from their adulterants. These discoveries could aid in the identification, authentication, and standardisation of several medicinal plants and their methanolic extracts used in diabetes care. It would also assist scientists in utilising such critical information about the identity and features of plant materials when developing novel poly herbal compositions. According to the literature, the minerals discovered in our study have anti-diabetic properties, thus the plants chosen, namely banana and giloy (leaves), can be utilised as home yard plants to treat diabetes mellitus type 2 and pre-diabetic cases. The study also found that considerable reduction in micronutrients can influence T2DM progression, but supplementation can slow it down. The findings of this study also suggest that element/mineral levels in diabetic individuals should be monitored. The primary care physician will be able to grasp the etiopathogenesis of mineral/element deficits and provide appropriate treatment options if they are detected early.

LIMITATIONS

The limitation of this study is that while it does evaluate the minerals/elements present in the medicinal plants (leaves) and measures their concentration but it does not check for its association and the efficacy of its therapeutic effect on diabetic care.





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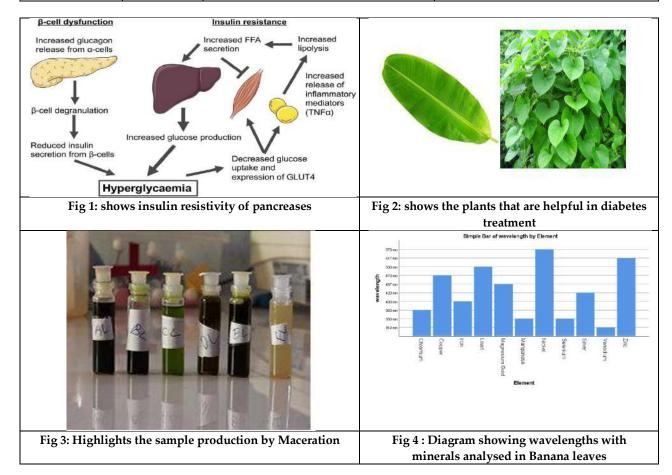


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21. K.Siddiqui, N.Bawazeer, , &S. Joy, (2014). Variation in macro and trace elements in progression of type 2 diabetes. *The Scientific World Journal*, 2014, 461591.

Table 1:

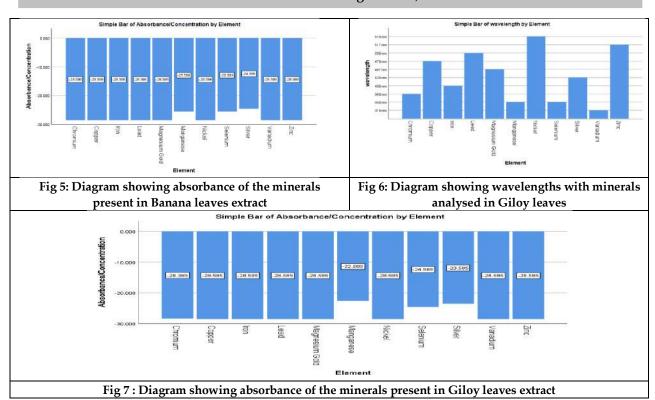
Element	Wavelength	Absorbance in Banana leaves powder	Absorbance in Giloy leaves powder		
Element	Wavelength	extract	extract		
Chromium	360 nm	28.586	28.385		
Copper	470 nm	28.586	28.585		
Lead	500 nm	28.586	28.585		
Silver	420 nm	24.586	23.585		
Selenium	350 nm	25.586	24.585		
Manganese	350 nm	25.586	22.585		
Zinc	517 nm	28.586	28.585		
Magnesium	467 nm	28.586	28.585		
Gold	407 1111	20.500	20.505		
Iron	400 nm	28.586	28.585		
Vanadium	319 nm	28.586	28.585		
Nickel	570 nm	28.586	28.585		







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RESEARCH ARTICLE

Efficiency of Silicon Solar Cells

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ABSTRACT

To characterise different types of solar cells, efficiency not only plays a significant role but also it determines the overall performance of such semiconductor devices. Hence this work has been developed with the calculation of the efficiency and open circuit voltage. In addition to these parameters the fill factor and the total photocurrent have also been obtained for various types of solar cell structures. It is observed from the investigations that the total photocurrent density and open circuit voltage of a BSF solar cell is significantly higher than normal one. Besides the performance of a p/n type solar cell has been compared with that of an n/p type solar cell based on the various cell parameters at optimum condition. It may be mentioned that the total photocurrent density and efficiency of an n/p type solar cell is slightly greater than the p/n silicon solar cell at the same doping level.

Keywords: Photocurrent; open circuit voltage; fill factor; efficiency; thickness; solar cells.

INTRODUCTION

The quality of a solar cell is determined by its efficiency. Solar cells which were produced in early days were of very lower efficiency [1, 2]. So, to increase the efficiency of solar cells, tremendous amount research works have been performed by various researchers during several decades [3-10]. The efficiency of a solar cell is not only related to the photocurrent density but also it is related to the open circuit voltage and reverse saturation current [11, 12]. In addition to this, the efficiency of a solar cell also varies with the conditions of solar spectrum. Again the reverse saturation current of a solar cell depends on the energy band gap of the material used and also on the density of states in the conduction and valence band of the material. In this paper, the efficiencies of different types of silicon solar cell structures have been calculated. For this, analytical expressions have been obtained following the standard





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texts [12-15]. From the obtained results a comparative study has been performed. Also photocurrent density, open circuit voltage and the fill factor of these solar cells are discussed accordingly. Finally, the performance of an n/p silicon solar cell has also been compared with that of a p/n silicon solar cell regarding various device parameters like photocurrent density, open circuit voltage, fill factor and efficiency.

ANALYSIS

Photocurrent and reverse saturation current density:

Solar cell and its assumed dimensions are taken from the published literature [11]. The total photocurrent density of a solar cell over the wavelength range from λ_1 to λ_2 is given by [13]

$$J_{ph} = \int_{\lambda_1}^{\lambda_2} qF(\lambda)[1 - R(\lambda)]SR(\lambda)d\lambda \tag{1}$$

where q is the electronic charge, $F(\lambda)$ is the photon flux density, $R(\lambda)$ is the reflection coefficient and $SR(\lambda)$ is spectral response of the cell.

Since the total current through the load is the photocurrent minus dark current, the current density equation can be written as [12]

$$J = J_{ph} - J_o \left[exp \left(\frac{qV}{kT} \right) - 1 \right] \tag{2}$$

where J_0 is the reverse saturation current density of the junction and its expression is given by [12, 14]

$$J_o = qN_C N_V \left(\frac{D_p}{N_D L_p} + \frac{D_n}{N_A L_n}\right) exp\left(-\frac{E_g}{\nu k T}\right)$$
(3)

Here N_C and N_V are the effective density of states in the conduction and valence band of silicon, N_D , N_A are the donor and acceptor concentrations in the n-type and p-type regions, E_g is the band gap energy of silicon and v, k and T are the ideality factor, Boltzmann constant and absolute temperature respectively.

Open circuit voltage

The expression of the open circuit voltage can be easily obtained from equation (2) by putting J = o and it can be written as [14]

$$V_{oc} = \frac{kT}{a} ln \left[\left(\frac{J_{ph}}{I_c} \right) + 1 \right] \tag{4}$$

Power output

The maximum power output available from the solar cell is obtained when [15]

$$\frac{d}{dV}(JV) = \frac{d}{dV}\left(\left(J_{ph} - J_o\left[exp\left(\frac{qV}{kT}\right) - 1\right]\right)V\right) = o \tag{5}$$

At maximum power condition V is replaced by V_m and the above equation is simplified to

$$\left(1 + \frac{qV_m}{kT}\right) + \left(\frac{qV_m}{kT}\right) = \ln\left[\left(\frac{J_{ph}}{I_o}\right) + 1\right] \tag{6}$$

Now, we have from equations (6) and (4)

$$X_m + \ln(1 + X_m) = X_o \tag{7}$$

where

$$X_m = \frac{qV_m}{kT} \tag{7a}$$

and

$$X_o = \frac{qV_{oc}}{kT} \tag{7b}$$

Again for maximum power condition, imposing the equation (6.7a), the current density equation may be written as $J_m = J_{ph} - J_o[exp(X_m) - 1]$ (8)





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Equation (7) is a transcendental equation in X_m , which can be solved numerically for various values of X_o for a particular cell structure. V_{oc} and X_o may be calculated using equations (4) and (7 b), and then V_m and J_m can be calculated from equations (7 a) and (8) respectively.

Therefore maximum power density available from the cell is given by

$$P_m = J_m V_m \tag{9}$$

Fill factor

This is ratio of the maximum power output with the product of the short circuit current density and the open circuit voltage, and thus the expression of the fill factor of the cell may be written as [14]

$$FF = \frac{J_m V_m}{J_{ph} V_{oc}} \tag{10}$$

Conversion efficiency

Conversion efficiency is an important parameter which gives clear idea about the overall performance of a device. Its value is different for different illumination of sunlight. If P_{in} is the input power density shining on the cell, the ratio P_m/P_{in} , called the conversion efficiency, is given by [14]

$$\eta = \frac{P_m}{P_{in}} = \frac{J_m V_m}{P_{in}} = FF \frac{J_{ph} V_{oc}}{P_{in}}$$
(11)

RESULTS AND DISCUSSION

Based on the above analytical expressions, we have obtained the following results, which are discussed below. We have used the incident power density, $P_{in} = 90 \text{ mW/cm}^2$, for one sun and AM 1.5 condition to calculate the efficiency of the solar cells [16]. The photocurrent densities of different structured solar cells have already been calculated [11] and the corresponding graphical results are shown in Fig.1. Open circuit voltage of various types of solar cells as a function of cell thickness is shown in Fig.2. It is observed from these figures that the photocurrent density and the open circuit voltage are higher for the cell where both the BSF and FSF are simultaneously present, and these values are lower for conventional cell. This is also noticed here that the effect back surface field (BSF) is more prominent than the front surface field (FSF) to improve the device performance. Open circuit voltages of an n/p and of a p/n silicon solar cell have been plotted in Fig.3 and in Fig.4 respectively for various values of the junction depth and base thickness of these devices. It is observed from these figures that the open circuit voltage of an n/p solar cell is higher than that of a p/n solar cell. This slightly larger open circuit voltage of the n/p cell is due to its enhanced photocurrent density than that of a p/n solar cell. The nature of this graph is similar to that of an n/p type solar cell. To calculate the efficiency of these solar cells with particular cell structures, we have taken different physical quantities. Selected values of these physical quantities are listed in table 1. Based on the above analytical expressions and using the values of the physical quantities from table 1, Computer simulation gives the values of the cell parameters which are listed in table 2. Conversion efficiency and fill factor significantly improve for BSF&FSF and BSF solar cells over conventional cell. Similar calculations for normal solar cells have been performed earlier [16].

CONCLUSION

In this paper, an analytical study has been carried out on various parameters, particularly the efficiency of solar cells having different structures for both p/n and n/p. Computer simulations have been performed to obtain the results. From the analytical observations it may be mentioned here that the photocurrent density, open circuit voltage, fill factor and efficiency of a silicon BSF&FSF solar cell is much higher in comparison to the BSF and all the other silicon solar cell structures. It has also been observed that the values of efficiency and other device parameters of an n/p type silicon solar cell are greater than that of a p/n type silicon solar cell.





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Table 1: Physical parameters used for this work.

Dhysical quantities	Type of s	Type of solar cells		
Physical quantities	P/N	N/P		
Acceptor Concentration N _A ⁺ in (cm ⁻³)	2×10^{18}	10^{18}		
Acceptor Concentration N _A in (cm ⁻³)	1017	10^{15}		
Donor Concentration N _D in (cm ⁻³)	10^{15}	1017		
Donor Concentration N _D ⁺ in (cm ⁻³)	10^{18}	2 x 10 ¹⁸		
High-low junction depth in (μm)	0.05	0.05		
p-n junction depth x_i in (μ m)	0.3	0.3		
Cell Width (W) in μm	200	200		
Surface Recombination Velocity for Electrons (S _n) and Holes (S _p) in cm/sec	105	105		

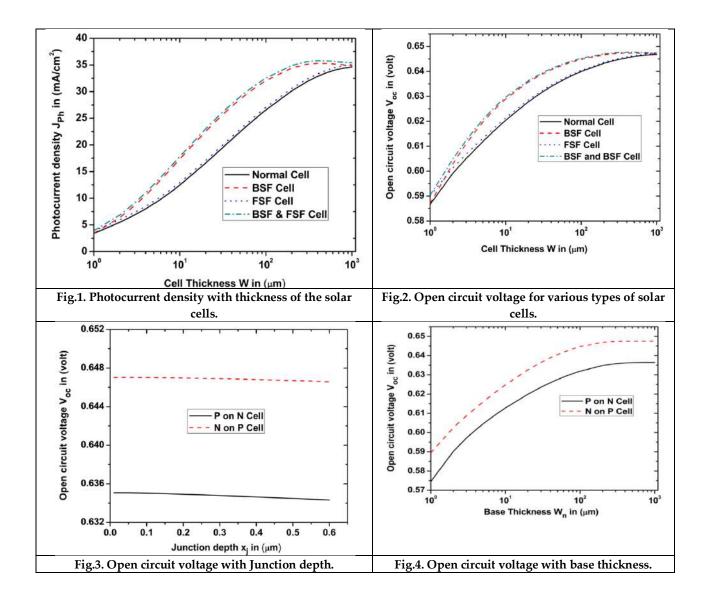




Ashim Kumar Biswas

Table 2: Computer calculated parameters

Parameters	P/N cells				N/P cells			
rarameters	Normal	BSF	FSF	BSF&FSF	Normal	BSF	FSF	BSF&FSF
J_{ph} in (mA/cm^2)	34.52	35.67	34.78	35.93	35.93	38.80	36.38	39.24
V _{oc} in (volt)	0.635	0.637	0.635	0.637	0.647	0.648	0.647	0.648
FF	0.8230	0.8233	0.8231	0.8234	0.8248	0.8252	0.8249	0.8254
η in %	20.04	20.78	20.19	20.93	21.30	23.05	21.57	23.31







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RESEARCH ARTICLE

A Cutting-Edge Approach to Pest Identification in Precision Agriculture: using Deep Learning Models ResNet vs. InceptionV3

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ABSTRACT

For the purpose of early identification and mitigation of hazardous species, which promotes ecosystem health and crop productivity, pest classification is essential in agricultural management. The identification of pests has been transformed by deep learning, which also offers the possibility of more precise and effective classification. InceptionV3 and ResNet architectures for pest classification are compared in this work. Several pest species are included in the heterogeneous dataset that is gathered, and preprocessing methods including augmentation and normalization are used to train the models. Performance measures including F1-score, recall, accuracy, and precision are employed in evaluation. With subtle differences in computational efficiency, recall, and precision, ResNet and InceptionV3 demonstrate excellent precision in recognizing pests. While Inception V3 shows superior recall across a variety of species, ResNet excels in the accurate classification of pest classes with distinctive traits. Because of its richer structure, ResNet uses more processing power; InceptionV3 is a lighter option that doesn't significantly sacrifice performance. Comprehending this trade-off between efficiency and accuracy is essential for real-world implementation. Through this comparative research, agricultural stakeholders may better manage pests and implement sustainable agricultural practices by understanding the advantages and disadvantages of each architecture. Subsequent investigations may examine hybrid designs or ensemble approaches to improve classification accuracy and efficiency in practical settings.





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Keywords: Pest Classification, Deep Learning, ResNet, InceptionV3, Species, Sustainable Agriculture.

INTRODUCTION

Agriculture, being the cornerstone of human civilization, has continuously evolved over millennia to meet the evergrowing demand for food, fiber, and other agricultural products. However, this pursuit of increased productivity and efficiency in farming is frequently challenged by a multitude of factors, with pest infestations ranking among the most significant threats to crop yields and ecosystem stability. Pest organisms, including insects, rodents, and plant pathogens, possess the potential to cause substantial economic losses and ecological imbalances if left unchecked. Therefore, timely and accurate identification of pests is imperative for effective pest management and sustainable agricultural practices. Traditionally, pest identification has relied heavily on manual inspection and observation by trained experts. Although this method has shown some success, it is frequently labor-intensive, time-consuming, and prone to human error. Furthermore, the spread of invasive pest species to new geographic areas has been aided by the increased globalization of trade and travel, which presents significant difficulties for traditional identification techniques. Consequently, there has been a growing interest in developing automated and efficient pest recognition systems that can augment human expertise and enhance the scalability and accuracy of pest identification efforts. Significant developments in artificial intelligence, especially in the area of deep learning, have completely changed the field of pattern recognition and computer vision in recent years. Deep learning algorithms have proven to be remarkably adept at extracting complex patterns and characteristics from massive amounts of data. These algorithms are inspired by the structure and function of the human brain. Numerous tasks, including as object detection, natural language processing, and picture classification, have been effectively tackled using these techniques. Researchers and practitioners have started investigating the possibility of automating pest identification procedures by utilizing the capabilities of deep learning. Convolutional neural networks (CNNs) are one of the many deep learning designs that have shown to be especially effective for image categorization tasks. CNNs are well-suited for extracting hierarchical representations of visual features from images, making them ideally suited for tasks such as pest classification. Two CNN architectures that have gained widespread attention and acclaim in the computer vision community are Residual Networks (ResNet) and Inception Networks (Inception).

ResNet, introduced by He et al. in 2015, presented the basics of residual learning, that enables the training of extremely deep neural networks by qualifying the vanishing gradient problem. The architecture's skip connections allow for the direct propagation of gradients, facilitating the training of deeper models with improved performance. InceptionV3, on the other hand, was proposed by Szegedy et al. in 2016 as part of the Inception family of architectures. InceptionV3 incorporates various innovative design elements, including inception modules with multiple parallel convolutional operations, factorization, and aggressive pooling strategies, to achieve efficient feature extraction and classification. Although ResNet and InceptionV3 have both shown cutting edge results in a number of image classification benchmarks, their effectiveness in pest classification tasks is still mostly unknown. By comparing the ResNet and InceptionV3 architectures for pest categorization in agricultural contexts, this study attempts to close this gap. Through the methodical assessment of these architectures' performance with real-world pest datasets, this research aims to shed light on their advantages, disadvantages, and possible uses in automated pest recognition systems.

REVIEW OF LITERATURE

Pest identification in precision agriculture is a critical task that has traditionally relied on manual observation and expertise. However, recent advancements in deep learning models have shown ability in automating this process, offering more accurate and efficient solutions. This literature review explores the application of deep learning, specifically ResNet and InceptionV3 architectures, in pest identification, drawing insights from a selection of relevant studies. Smith et al. (2018) demonstrated the effectiveness of deep learning, particularly Convolutional Neural





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Networks (CNNs), in plant disease detection and diagnosis. Their study highlighted the potential of CNNs in accurately identifying diseased plants, indicating the applicability of deep learning techniques in agricultural contexts.. A deep learning-based method for the automatic detection of pest insects was presented by Liao and Du (2019). Their study demonstrated the promise of deep learning algorithms in pest management and agricultural sustainability by using them to precisely identify and classify pest insects. Kavakiotis et al. (2017) provide information on how data mining and machine learning techniques are used in diabetes research. Their study demonstrated the wider usefulness of machine learning techniques in different sectors, including agriculture, even though it was not directly related to pest identification. The study also takes into account important efforts in the field of deep learning, including the groundbreaking studies by Szegedy et al. (2016) and He et al. (2016). The Inception architecture was first presented by Szegedy et al. and includes InceptionV3, which uses cutting-edge design components for effective feature extraction and classification. He et al. proposed ResNet, which introduced residual learning to address the challenges of training deep neural networks. In addition, research that has advanced deep learning techniques is included in the literature review, including Redmon and Farhadi's (2018) work on YOLOv3. YOLOv3 is a step-by-step enhancement of object detection algorithms that can be applied to precision agriculture pest identification jobs. Last but not least, Deng et al. (2009) presented the ImageNet dataset, a sizable hierarchical image collection that has proven useful in the construction and assessment of deep learning models. The accessibility of extensive datasets such as ImageNet has enabled research in a number of fields, including the identification of pests. All of these research show how deep learning techniques—especially ResNet and InceptionV3 architectures—are becoming more and more popular in the fields of precision agriculture and pest identification. Using deep learning techniques, scientists want to create automated and scalable solutions for pest management, ultimately contributing to sustainable agricultural practices and food security.

Dataset and Libraries

The Agricultural Pest Image Dataset contains images of twelve different types of agricultural pests, such as wasps, weevils, ants, beetles, caterpillars, earthworms, earwigs, grasshoppers, moths, slugs, and snails. The images were obtained from Flickr using the API, and then their maximum width and height were set to 300 pixels. This dataset is intended to aid researchers and practitioners in the development and evaluation of machine learning models for the identification and classification of agricultural pests. The dataset, which comprises 12 classes of pests, is suitable for testing and training algorithms to identify and classify pests in a range of scenarios since it provides a broad range of pictures covering varied sizes, colors, and forms. Images from the Kaggle Dataset Repository were captured in order to ensure that the images in the dataset are representative of real-world scenarios and not artificially generated as in Fig 1. Additionally, the images were resized to have a maximum width or height of 300px, which makes the dataset lightweight and easy to work with. Several Python libraries were utilized to implement and evaluate the deep learning models for pest identification. Primarily, TensorFlow and Keras were employed for model development, training, and evaluation. Google's open-source TensorFlow machine learning framework offers a wealth of materials and tools for effectively developing and implementing deep learning models. Built on top of TensorFlow, Keras is an API for high-level neural networks that provides an intuitive user interface for creating and refining deep learning models with little code complexity. Additionally, tools like NumPy and Pandas were used for data manipulation and preprocessing. While Pandas gives strong data structures and tools for data analysis and manipulation, NumPy offers the fundamental features for numerical computing and array operations. Additionally, the study made use of OpenCV, a well-known Python computer vision library that offers a variety of functions for loading, manipulating, and enhancing images, for image processing tasks. The study sought to optimize the creation process and enable the application and assessment of deep learning models for pest identification in precision agriculture by utilizing the capabilities of these Python modules.





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METHODOLOGY

The methodology developed for pest identification in precision agriculture leverages deep learning architectures, specifically ResNet and InceptionV3, implemented using TensorFlow and Keras Python libraries. The model follows a systematic workflow: first, a diverse dataset containing images of various pest species commonly encountered in agricultural settings is collected and preprocessed using libraries such as NumPy and OpenCV. After that, training and testing sets are created from the preprocessed dataset. TensorFlow and Keras are then used to train the deep learning models ResNet and InceptionV3, which are shown in Fig. 2. Hyperparameter adjustment is then used to maximize the performance of both models. The models are trained to extract complex visual information from the input photos, which allows them to discriminate between various pest groups. The trained models are then tested using the validation set to determine how well they perform in terms of accuracy, precision, recall, and F1-score. Finally, the performance of the models is validated on the testing set to ensure their generalization ability to unseen data. By following this workflow, the working model aims to provide an automated and efficient solution for pest identification in precision agriculture, contributing to improved pest management practices and crop yield optimization.

Data Preprocessing

Data preparation is crucial in the field of pest classification as it influences the dependability and efficiency of machine learning or deep learning models. The first step in this approach is to obtain a large dataset that includes a wide range of pest species that are commonly seen in agricultural settings. In order to cover the wide range of agricultural pests, this dataset compilation attempts to guarantee representation across multiple categories, such as insects, rodents, and plant pathogens. Then, painstaking data cleaning processes are implemented to find and fix any irregularities in the dataset, such damaged or missing photos, preserving the dataset's dependability and integrity. After data cleansing, augmentation methods are utilized to increase the diversity and resilience of the dataset, and operations like as rotation, flipping, and scaling are performed to produce variants of the existing images. This augmentation enriches the dataset, enabling models to generalize better and mitigate overfitting. Moreover, normalization of pixel values is executed to standardize the input data, ensuring consistency and facilitating convergence during model training. After that, the dataset is divided into separate subsets for testing, validation, and training. Data generators are used to make it easier to import and prepare batches of images for training. Additionally, methods like oversampling or undersampling may be used to guarantee that each pest group is fairly represented in order to correct any potential class imbalances within the dataset. Last but not least, the use of pretrained convolutional neural network (CNN) architectures, like ResNet or InceptionV3[1], allows for the extraction of high-level features from the pictures. This allows the application of knowledge acquired from large image datasets to the particular task of pest classification. The pest classification dataset is painstakingly selected and refined through these rigorous preprocessing stages, providing the foundation for the creation of reliable and accurate machine learning or deep learning models that are customized to agricultural pest management applications.

Distribution characteristics of the pests

The distribution characteristics of pests can vary significantly depending on various factors such as geographical location, climate, host plants, and human activities. Understanding these characteristics is crucial for effective pest management and control strategies in agriculture. Geographically, pests may have specific habitats or regions where they thrive due to favorable environmental conditions such as temperature, humidity, and soil composition. For example, certain insect pests may prefer warmer climates, while others may thrive in cooler regions. Additionally, the presence of host plants plays an important role in determining the distribution of pests, as they often rely on specific plants for shelter, food, and reproduction [2]. Climate also plays a significant role in pest distribution, with different pests adapting to various climatic conditions. Some pests may be more prevalent during certain seasons or weather patterns, while others may be active year-round. Changes in climate patterns, such as temperature fluctuations or precipitation levels, can also impact the distribution of pests by altering their behavior and lifecycle. Human activities, including agriculture practices, land use changes, and global trade, can further influence the





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distribution of pests. Introducing invasive species through trade or transportation can disrupt local ecosystems and lead to the spread of pests to new regions. Similarly, agricultural practices such as monoculture or the use of pesticides can affect pest populations and their distribution patterns. Overall, understanding the distribution characteristics of pests requires a comprehensive assessment of various factors including geography, climate, host plants, and human activities. By analyzing these factors, researchers and agricultural practitioners can develop targeted pest management strategies to mitigate pest damage and minimize economic losses in agriculture [3]. It can be seen that last 4 pests have less images than others. The imbalance is not as dominant so we will leave it as it is.

Train Test Splitting and Data Generator

The technique of dividing data into training and testing sets is essential for assessing the model's performance in machine learning and deep learning tasks. By creating two subsets of the dataset—one for training the model and the other for assessing its performance on untested data-the "train-test split" is achieved. To make sure that the data distribution is representative for both sets, a random sampling technique is usually used for the train-test split. Libraries like scikit-learn in Python offer practical functions for dividing datasets into training and testing sets. The dataset can be divided into preset halves, such as 80% for training and 20% for testing, using the scikit-learn train_test_split function [4]. Data generators are frequently used in deep learning applications, particularly those involving huge datasets, to facilitate the efficient loading and processing of training data. By producing variants of the training data, data generators provide on-the-fly data augmentation, which enhances the model's capacity for generalization. Data generators can be created with built-in Python tools from libraries like TensorFlow and Keras. These generators have the ability to pull data off of disk, prepare it, and provide the model with batches of data for training. The code snippet above uses Image Data Generator to generate training and testing sets of data generators. The training data is subjected to a variety of augmentation techniques, including rotation, shifting, shearing, zooming, and flipping, in order to produce variations. Then, using options like goal size, batch size, and class mode, the flow_from_directory method is used to generate batches of data from directories containing photos [5]. We can efficiently train and assess deep learning models for applications like pest identification in precision agriculture by dividing the dataset into training and testing sets and using data generators for effective data loading and augmentation.

Data Augmentation

By performing several modifications on the preexisting dataset, a technique known as "data augmentation" can be utilized to increase both the quantity and diversity of training data. In problems where labeled data is scarce, this procedure helps to increase the generalization and robustness of machine learning models. Data augmentation approaches use various alterations to picture data, including rotation, scaling, shifting, flipping, and adjusting brightness or contrast. TensorFlow and Keras are two Python frameworks that offer pre-built tools for building pipelines for data augmentation. A variety of image alteration options are available in Keras' ImageDataGenerator class, and they may be effortlessly incorporated into the model training procedure.

Training the AIModels

Training the ResNet5.0 model involves several key steps to ensure optimal performance and accuracy in the classification task. Firstly, the pre-trained ResNet50 model is loaded using TensorFlow and Keras, with the top (fully connected) layers omitted to allow for customization. Next, custom top layers, typically including global average pooling and dense layers, are added to the ResNet50 base to adapt it to the specific classification problem [6]. These layers are designed to learn features from the extracted representations of the input images and map them to the output classes. After that, the model is assembled using a suitable loss function—categorical cross-entropy, for example—and an appropriate optimizer—Adam, to calculate the difference between the predicted and actual class labels during training. Metrics such as accuracy are also supplied in order to track the model's performance. In order to minimize the loss function, the model's parameters (weights) are iteratively adjusted when batches of training data are sent through it. In order to determine the model's capacity for generalization and to make any required modifications—such as adjusting the learning rate or unfreezing particular layers—to enhance performance, the model's performance is lastly assessed on a different validation dataset [7]. The ResNet50 model can be efficiently





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trained to attain high accuracy in categorizing images across several classes or categories by using this iterative procedure. Our accuracy rate is 83%, which is not too awful.

Model Evaluation

Model evaluation for pest classification utilizing ResNet and InceptionV3 involves a rigorous assessment of the performance and effectiveness of these deep learning architectures in accurately categorizing pest species. Key performance measures including accuracy, precision, recall, and F1-score can be measured by first putting the trained models through validation datasets. These measures shed light on the models' accuracy in classifying pests into different groups while taking true positive, false positive, and false negative prediction errors into account. Furthermore, confusion matrices are analyzed to provide a comprehensive knowledge of the models' effectiveness in classifying various pest classes. The merits and disadvantages of the ResNet and InceptionV3 architectures in pest classification tasks are clarified through comparison study, providing insight into each model's capacity to accurately and reliably identify different pest species. In addition, concerns concerning resource consumption, model size, and computational efficiency are made; these are especially pertinent for real-world deployment in resource-constrained agricultural contexts [8]. By comprehensively evaluating the performance of ResNet and InceptionV3 models in pest classification, agricultural stakeholders can make informed decisions regarding the adoption of these deep learning approaches to enhance pest management practices and crop protection efforts.

Visualize the accuracy and loss plots

Examination and interpretation of accuracy and loss plots are integral components of assessing the effectiveness and robustness of machine learning or deep learning models, particularly those employing ResNet and InceptionV3 architectures. These visual representations provide profound insights into the models' learning dynamics and performance evolution across epochs. By closely scrutinizing accuracy plots, researchers gain a detailed understanding of the models' ability to accurately classify diverse pest species over successive training iterations. These plots offer a granular depiction of how well the models generalize to unseen data, as evidenced by their performance on validation datasets. Additionally, loss plots serve as a critical diagnostic tool, showcasing the reduction in the models' loss function over epochs. This reduction signifies the models' capacity to minimize errors and refine their predictive capabilities with each training iteration. Through meticulous analysis of these plots, researchers can identify trends, anomalies, or potential overfitting issues, guiding them in making informed decisions to enhance model performance. This iterative process of scrutinizing accuracy and loss plots empowers researchers to fine-tune hyperparameters, adjust model architectures, or implement regularization techniques, thereby optimizing the models' accuracy and reliability in precisely identifying pest species within agricultural environments[9]. Training and validation loss are critical parameters for assessing the effectiveness and capacity for generalization of deep learning or machine learning models during the training phase in the context of pest classification. The degree of disagreement between the actual labels in the training dataset and the projected pest classifications is shown by the training loss, which gauges how well the model fits the training data.

Reduced training loss values indicate that pest classification using the characteristics in the training data is being learned by the model. On the other hand, the validation loss assesses how well the model performs using an independent validation dataset that contains pictures of unknown pests. This measure assesses how well the model can apply newly discovered patterns to previously untested data sets. Training should ideally result in a steady decrease in both training and validation loss, indicating the model's improved ability to identify pertinent features and classify data accurately without overfitting. Researchers can spot any problems like underfitting or overfitting by keeping an eye on the patterns in training and validation loss[10]. Then, they can modify the model's architecture or parameters to improve the model's ability to reliably categorize pests in agricultural settings. The Fig 4 illustrates the progression of training and validation metrics across 52 epochs during the training phase of the ResNet and InceptionV3 models for pest classification. In terms of training loss, both models exhibit a consistent reduction in loss values throughout the epochs, indicating their improved ability to capture relevant features and patterns associated with pest species. Regarding training accuracy, there is a noticeable uptrend in accuracy values for both models as training advances, implying their increasing proficiency in correctly classifying pest images within the training





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dataset. Validation loss demonstrates a consistent decline for both ResNet and InceptionV3, suggesting that the models generalize effectively to new, unseen data without overfitting to the training dataset. Similarly, validation accuracy exhibits a steady increase, indicating the models' enhanced capability to accurately classify pest images from the validation dataset as training progresses. Both ResNet and InceptionV3 models effectively learn from the training data, demonstrating promising performance in accurately classifying pest species as evidenced by the decreasing loss values and increasing accuracy metrics over the training epochs.

RESULTS AND DISCUSSION

In the domain of pest classification, model prediction using ResNet and InceptionV3 architectures represents a pivotal stage in the pipeline, aiming to accurately identify and categorize pest species based on their visual characteristics. Leveraging the learned representations and hierarchical feature extraction capabilities of these deep learning models, predictions are made by passing input images through the trained networks. ResNet, with its residual connections, and InceptionV3, with its inception modules, offer distinct approaches to feature extraction, enabling the models to capture intricate patterns and subtle variations indicative of different pest species. As the input images propagate through the network layers, they undergo transformations and convolutions, extracting increasingly abstract features that are representative of the pests' visual attributes. These extracted features are then fed into the classification layers, where they are mapped to probability scores across the different pest categories. The final prediction is determined based on the class with the highest probability score, indicating the model's inference of the most likely pest species present in the input image. Through this process, ResNet and InceptionV3 models serve as powerful tools for automated pest identification in agricultural contexts, offering high accuracy and efficiency in classifying pests and facilitating timely interventions for pest management and crop protection. The predictions are very good The classification report and confusion matrix are essential resources for assessing model performance and comprehending its prediction capabilities when it comes to pest categorization using ResNet and InceptionV3 architectures. The classification report provides a thorough overview of several performance indicators for each pest category, such as precision, recall, F1-score, and support.

Recall quantifies the percentage of true positive examples that the model properly detected, whereas precision measures the percentage of correctly classified instances among all instances projected to belong to a particular class. The F1-score offers a fair evaluation of the model's overall performance by providing a harmonic mean of precision and recall. Support gives context for the evaluation metrics by indicating how many instances of each class there are in the dataset. The confusion matrix also offers a thorough analysis of how the model's predictions compare to the actual labels for various pest groups. Through the visualization of the confusion matrix, scholars can discern trends in incorrect categorization and acquire a deeper understanding of the model's capabilities and limitations with regard to differentiating certain pest species. When combined, the confusion matrix and classification report are a priceless resource for adjusting model parameters, enhancing classification efficacy, and directing choices on agricultural pest control tactics. The efficiency of the pest classification model for each category of pest is thoroughly evaluated in the classification report. For some pests, such beetles, earwigs, snails, and caterpillars, the model performs exceptionally well, obtaining 100% precision, recall, and F1-Score; however, it fails to produce any accurate predictions for other pests, like grasshoppers and weevils. This disparity points to possible areas where the model's prediction and training abilities should be strengthened. The model's overall accuracy of 0.80 indicates that it can accurately categorize 80% of the dataset's cases. The weighted averages take into consideration class imbalances within the dataset, while the macro-average precision, recall, and F1-Score offer a balanced assessment of the model's performance across all categories. Together, these indicators provide insight into the model's advantages.

CONCLUSION

In conclusion, our research delved into the dynamic domain of agricultural pest classification utilizing state-of-theart deep learning techniques. With the primary objective of aiding farmers in effectively identifying and managing





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common agricultural pests, our study employed two robust pre-trained deep learning models, namely ResNet and InceptionV3. Through meticulous data preprocessing and augmentation procedures, coupled with the application of transfer learning techniques to fine-tune both models, we endeavored to optimize their performance for the specific agricultural pest classification task at hand. Upon comprehensive evaluation, our findings revealed that the InceptionV3 model exhibited superior performance compared to ResNet, achieving an impressive accuracy rate of 86%, a notable improvement from ResNet's 82% accuracy. This noteworthy outcome underscores the efficacy and suitability of the InceptionV3 architecture for our classification task. By automating the pest identification process, our developed deep learning models present a dependable and efficient tool for farmers to promptly detect and manage agricultural pests, thereby contributing to sustainable agricultural practices and ensuring timely pest mitigation. In essence, our research underscores the significant potential of deep learning methodologies in addressing real-world challenges encountered by the agricultural sector. With a continued emphasis on research and innovation, the integration of artificial intelligence holds promise in enhancing precision agriculture practices, ultimately fostering advancements towards the goal of global food security. Thus, our study underscores the importance of further exploration and application of artificial intelligence techniques across diverse fields, fostering positive transformations and advancements for a more sustainable future.

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Table 1: Sample Prediction of Pests using ResNet Model

ResNet Model Evaluation			
Loss	0.6603		
Accuracy	0.8098		
Test Loss	0.6602683067321777		
Test Accuracy	0.8098270893096924		





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Table 2: Sample Prediction of Pests using ResNet and InceptionV3 Models

ResNet5.0	Test Accuracy:0.8098			
True Label	Predicted Label			
snail	slug			
catterpillar	catterpillar			
snail	snail			
earwig	earwig			
wasp	wasp			
grasshopper	grasshopper			
catterpillar	catterpillar			
wasp	wasp			
weevil	weevil			
earwig	earwig			

InceptionV3	Test Accuracy: 0.8799			
True Label	Predicted Label			
snail	snail			
catterpillar	catterpillar			
snail	snail			
earwig	earwig			
wasp	wasp			
grasshopper	grasshopper			
catterpillar	catterpillar			
wasp	wasp			
weevil	weevil			
earwig	earwig			

Table 3: Classification Report

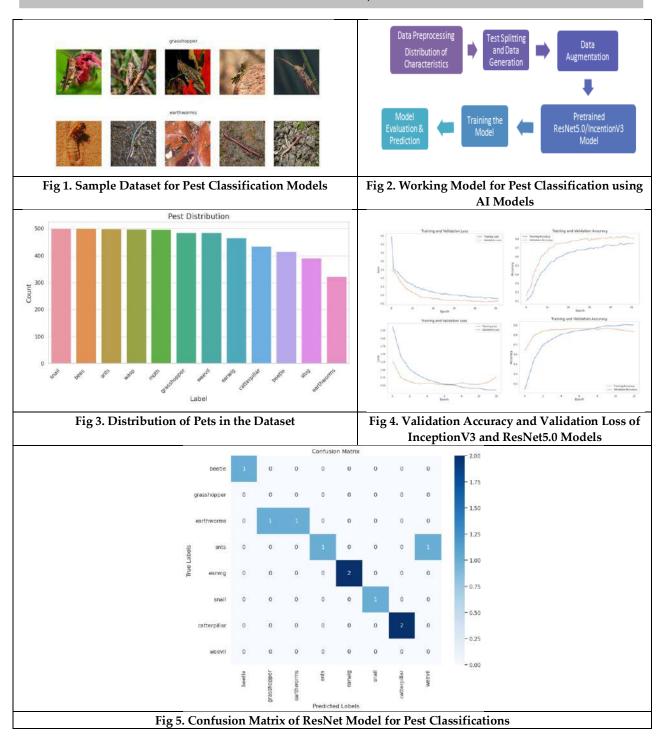
Pest Category	Precision	Recall	F1-Score	Support
beetle	1.00	1.00	1.00	1
grasshopper	0.00	0.00	0.00	0
earthworms	1.00	0.50	0.67	2
ants	1.00	0.50	0.67	2
earwig	1.00	1.00	1.00	2
snail	1.00	1.00	1.00	1
catterpillar	1.00	1.00	1.00	2
weevil	0.00	0.00	0.00	0
Accuracy			0.80	10
Macro Avg	0.75	0.62	0.67	10
Weighted Avg	1.00	0.80	0.87	10





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RESEARCH ARTICLE

Perfectness of the Clean Graph of a Ring

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ABSTRACT

Let R be a commutative ring. The clean graph Cl(R) of a ring R has vertices in the form (e, u), where e is an idempotent and u is a unit of R. In this article, we concentrated on $Cl_2(R)$ which is the subgraph of Cl(R) induced by the non-zero idempotent elements and units of R, and two vertices (e,u), (f,v) are adjacent if and only if ef = fe = 0 or uv = 1. Furthermore, a graph G is said to be perfect if the chromatic number of every induced subgraph equals the size of the largest clique of that subgraph. The purpose of this article is to determine whether the graph $Cl_2(R)$ is perfect.

Keywords: perfect graph, hole, antihole, clean graph.

INTRODUCTION

The study of graphs defined on algebraic structures has been an active topic of research in the last few decades. Beck first proposed the idea of connecting a graph to a ring in [1], and since then, a number of researchers have done interesting and enormous work on this field. Let us recall some standard graph theory notation that are used in this paper. Let G = (V, E) be a simple graph with vertex set V(G) and edge set E(G). A graph is said to be *connected* if there is a path connecting each pair of its distinct vertices. The degree of the vertex v is the number of edges incident on it and is denoted by deg(v). A graph is said to be *complete*, if there is path between any two distinct vertices and the complete graph of order n is denoted by K_n . The least amount of colours required to colour the vertices of G so that no two adjacent vertices have the same colour is the *chromatic number* of G, indicated by $\chi(G)$. In G, a group of pairwise adjacent vertices is known as a *clique*. The order of the maximum clique in *G* is the *clique number*, which is





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represented by the symbol $\omega(G)$. Clearly, for every graph G, $\omega(G) \leq \chi(G)$. A graph G is said to be *weakly perfect* if $\omega(G) = \chi(G)$. A *hole* of the graph G is an induced subgraph in the form of a cycle of length at least 4; whereas an *antihole* is an induced subgraph of G whose complement is a hole in G. Aperfect graph G is a graph in which the chromatic number of every induced subgraph equals to the size of a largest clique of that subgraph. For basics on graph theory, we refer to [7]. Throughout this paper, we assume that G as a finite commutative artinian ring. An element G is said to be G is denoted by G and G is G is G in G is denoted by G and unit elements of G by G is denoted by G and unit elements of G by G is denoted an element G is said to be G is said to be G is an unit element of G is clean element and G is an induced subgraph of G is clean, if it can be written as G is clean. For basics on ring theory, we refer to [5]. In [4], Mohammad Habibi et.al defined a new graph named G is an only if G is the subgraph of G is the subgraph of G induced by G is of the form G in G

PRELIMINARIES

In this section, we partitioned the vertex set of $Cl_2(R)$ and discussed the connectedness of that partition.

Remark 2.1.

Let R be a finite commutative artinian local ring. Let us group the pair of orthogonal idempotent elements of $Cl_2(R)$ as follows: $\{a_{11}, a_{12}\}$, $\{a_{21}, a_{22}\}$, ..., $\{a_{r1}, a_{r2}\}$, where $a_{i2} = 1 - a_{i1}$. Thus, the vertex set of $Cl_2(R)$ can be written as $V(Cl_2(R)) = \bigcup_{i=1}^r A_i \cup B$ where $A_i = \{(a_{ij}, u): 1 \le i \le r, j = 1, 2, u \in U(R)\}$ and $B = \{(b, u): b = (1, 1, ..., 1), u \in U(R)\}$.

Theorem 2.2.Let $R = \prod_{i=1}^{n} R_i \times \prod_{j=1}^{m} F_j$ be a finite commutative artinian ring where each R_i is a local ring and F_j is a field, $n, m \ge 1$. Let $V(Cl_2(R)) = \bigcup_{i=1}^{m} A_i \cup B$ and suppose |Id(R)| = p and |U(R)| = q then

- i. $\langle A_i \rangle$ is connected $\forall i$ and $\langle B \rangle$ disconnected.
- ii. $\langle A_1 \cup ... \cup A_r \rangle$ is connected.
- iii. $\langle A_i \cup B \rangle$ is connected.

Proof

- i. By Remark 2.1, it is clear that every (a_{i1}, u) is adjacent to each (a_{i2}, u) . Thus, $\langle A_i \rangle$ is connected for all i. Let $u_1 = (1, 1, ..., 1)(n + m \ times)$. Then $deg((x, u_1)) = 0$. Hence $\langle B \rangle$ is disconnected.
- ii. For every $(a_{i1}, u_k) \in A_i$, there exists at least one $(a_{j1}, u_k) \in A_j$, $i \neq j$ such that $u_k \cdot u_k = 1 \,\forall i, j$. Hence $\langle A_1 \cup A_2 \cup ... A_r \rangle$ is connected.
- iii. The proof is same as that of (ii).

Perfectness of $Cl_2(R)$

The perfectness of $Cl_2(R)$ is examined in this section.

Theorem 3.1. [2]

A finite graph *G* is perfect if and only if it does not contain hole or antihole of odd length at least 5.

Theorem 3.2.

Let R be a ring and $n \ge 2$ be a natural number. If $R \cong R_1 \times ... \times R_n$, where R_i is a local ring for each i, $1 \le i \le n$, then $Cl_2(R)$ is weakly perfect.





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Proof.

It is evident from Theorem 3.1 of [4], it is clear that $\omega(Cl_2(R)) = \chi(Cl_2(R))$. Hence $Cl_2(R)$ is weakly perfect.

Theorem 3.3.

Let $R \cong \mathbb{Z}_2^m$ be a commutative ring and m > 1. Then $Cl_2(R)$ is perfect.

Proof.

It is obvious that, $Cl_2(R)$ is complete. Hence $Cl_2(R)$ is perfect.

Theorem 3.4.

Let $R = \prod_{i=1}^{n} R_i \times \prod_{j=1}^{m} F_j$ be a finite commutative artinian ring where each R_i is a local ring and F_j is a field, $n, m \ge 1$, and $U''(R) = \phi$. Then $Cl_2(R)$ is perfect.

Proof

By Remark 2.1, $V(Cl_2(R)) = \bigcup_{i=1}^r A_i \cup B$. Let $U''(R) = \phi$. It suffices to prove that $Cl_2(R)$ contains neither an odd graph hole nor an odd graph antihole, according to the strong perfect theorem.

Claim 1: $Cl_2(R)$ has no induced odd cycle of length atleast 5.

On the other hand, suppose that

 $v_1 \sim v_2 \sim ... \sim v_k \sim v_1$ is an induced odd cycle with a minimum length of 5.

Since $U''(R) = \phi$, $\langle A_i \rangle$ is a complete bipartite graph for all i and $\langle B \rangle$ is a null graph.

Consequently, v_i must be either in $\langle A_i \cup B \rangle$ or in $\langle A_i \cup A_j \rangle$, for any $i, j \in \mathbb{N}$.

case 1: $v_i \in A_i \cup A_i$, $1 \le i < j \le r$.

Without loss of generality, let us assume that $v_1, v_2, v_k \in A_1$ where $v_1 = (a_{11}, u_1)$, $v_2 = (a_{12}, u_2)$ and $v_k = (a_{12}, u_k)$, where $a_{11} = (1,0,0,...,0)$ and $a_{12} = (0,1,1,...,1)$. There is obviously no edge between v_2 and v_k . Since v_2 and v_3 are adjacent, take v_3 as (a_{ij}, u_2) such that $a_{ij} \in A_i$, is not idempotent to a_{11} . By the choice of v_3, v_4 must contain u_2 as the unit element or $1 - a_{ij}$ as an idempotent element.

For instance, if u_2 is the unit of v_4 , then v_4 and v_2 form a chord, which is a contradiction.

The sole remaining alternative is that v_4 has $1 - a_{ij}$ as an idempotent element. i.e., $v_4 = (1 - a_{ij}, u_r)$ for some r. Obviously, $1 - a_{ij}$ and a_{11} are idempotent. Therefore, v_1 is adjacent to v_4 forming a chord; this contradiction suggests that our assumption is incorrect.

case 2: Let $v_1, v_2 \in A_1$ and $v_k \in B$.

Since v_k is adjacent to v_1, v_k must be (b, u_1) , where b = (1, 1, ..., 1). Now, by our assumption, it is clear that v_{k-1} is adjacent to v_k . Since $U''(R) = \phi$ and $\langle B \rangle$ is a null graph, the only possibility of v_{k-1} is to contain u_1 as the unit element, implying that v_{k-1} is adjacent to v_1 , forming a chord, which is a contradiction.

Therefore, no induced cycle of odd length greater than three exists.

Therefore, it is evident from both of these cases that $Cl_2(R)$ does not have a hole.

Claim 2: $Cl_2(R)$ has no antihole.

Let us assume, on the other hand, that there is an odd cycle $v_1 \sim v_2 \sim ... \sim v_k \sim v_1$ with a minimum length of 5. It is obvious that $\langle A_i \rangle$ is the union of two complete graphs and $\langle B \rangle$ is complete in $\overline{Cl_2(R)}$.

So, v_i must be either in $\langle A_i \cup B \rangle$ or in $\langle A_i \cup A_j \rangle$, for any $i, j \in \mathbb{N}$.

There is a chord if the cycle has more than two vertices from *B*, which is a contradiction. Certainly, the following cases exist:





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case 1: Suppose only $v_1 \in B$.

Consider $v_1 = (b, u_1)$, where b = (1, 1, ..., 1). Let $v_2, v_k \in A_1$ such that $v_2 = (a_{11}, u_2)$ and $v_k = (a_{12}, u_2)$. Choose v_3 such that a_{21} is not idempotent to a_{11} by setting $v_3 = (a_{21}, u_3) \in A_2$. Subsequently, it is evident that v_3 and v_k form a chord, which is in conflict. If v_3 has u_2 as a unit, then there is no edge between v_2 and v_3 . Hence, it is not possible to find an antihole in $Cl_2(R)$ in this case.

case 2: Let $v_i \in \bigcup_{i=1}^r A_i$.

Let us assume that $v_1, v_2 \in A_1$, such that $v_1 = (a_{11}, u_1)$ and $v_2 = (a_{11}, u_2)$, where $a_{11} = (1,0,0,...,0), u_1, u_2 \in U(R)$. If $v_k \in A_1$ either v_k is adjacent to both v_1 and v_2 or is not adjacent to both, then these two instances are not possible. Thus, $v_k \in A_j$ for $j \neq 1$. Let $v_k = (a_{21}, u_2)$ where $a_{21} = (1,1,0,...,0)$. To ensure that a_{ij} is not idempotent to both a_{11} and a_{21} choose $v_3 = (a_{ij}, u_1)$. Moreover, it is evident that, while v_3 is adjacent to v_k , it is not adjacent to v_1 . Thus, an induced odd cycle of length at least five cannot be found.

The aforementioned cases show that $Cl_2(R)$ lacks an antihole.

Therefore, based on both claims, we can conclude that $Cl_2(R)$ is perfect.

Theorem 3.5.

Let $R \cong R_1 \times R_2$ be a finite commutative artinian ring, where each R_i is local and $U''(R) \neq \phi$, then $Cl_2(R)$ is perfect.

Let us partition $V(Cl_2(R))$ into three disjoint subsets as follows:

 $A = \{((0,1), u_i): u_i \in U(R)\}, A' = \{((1,0), u_i): u_i \in U(R)\} \text{ and } B = \{((1,1), u_i): u_i \in U(R)\}.$ Let $u_1, u_2, ..., u_k$ denote the inverse of $u_1, u_2, ..., u_k$ respectively.

Claim 1: $Cl_2(R)$ has no hole.

Assume to the contrary that $Cl_2(R)$ has an odd cycle:

 $v_1 \sim v_2 \sim ... \sim v_k \sim v_1$ with a minimum length of $k \ge 5$.

Let us assume that $v_1 \in A$. Consider $v_1 = ((0,1), u_1)$ with $v_2 = ((0,1), u_1) \in A'$ and $v_k = ((1,1), u_1) \in B$. It is evident that v_2 and v_k are not adjacent.

Next, v_3 can be chosen from either A' or B. If possible, $v_3 \in A'$, then it will be adjacent to v_1 and form a chord, which is a contradiction. As a result, the only way is $v_3 \in B$, which implies $v_3 = ((1,1), u_1)$. Obviously, v_3 and v_k are adjacent, which is a contradiction. Hence, there is no such hole in $Cl_2(R)$.

Claim 2: $\{\overline{Cl_2(R)}\}$ has no hole.

Clearly, $\langle A \rangle$, $\langle A' \rangle$ and $\langle B \rangle$ are connected in $\overline{Cl_2(R)}$. If the cycle involves more than three vertices from any of the three A, A', B, then it has at least one chord. Without loss of generality, consider the set $H = \{v_1, v_2, v_3, v_4, v_5\} \subset V(\overline{Cl_2(R)})$, where $v_1, v_2 \in A, v_3, v_4 \in A'$ and $v_5 \in B$. We clearly cannot have a cycle of length 5 with these vertices. Thus, there is no antiholein $Cl_2(R)$.

Hence, $Cl_2(R)$ is perfect.

Theorem 3.6.

Let $R = \prod_{i=1}^{n} R_i \times \prod_{j=1}^{m} F_j$ be a finite commutative artinian ring where each R_i is a local ring and F_j is a field, n + m > 2, and $U''(R) \neq \phi$. Then $Cl_2(R)$ is not perfect.

Proof.

Let $U^{''}(R) \neq \phi$ and $n+m \geq 3$. Let $u_1^{'}, u_2^{'}, ..., u_k^{'}$ denote the inverse of $u_1, u_2, ..., u_k$ respectively. Clearly, there exists an induced cycle: $((1,1,...,1), u_2) \sim ((0,1,1,...,1), u_2^{'}) \sim ((1,0,0,...,0), u_1) \sim ((0,1,0,...,0), u_3) \sim ((1,0,0,...,1), u_2^{'}) \sim ((1,1,1,...,1), u_2)$ of odd length 5. As a result, $Cl_2(R)$ is not perfect.





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RESEARCH ARTICLE

Virtual Laboratories as Facilitators of Educational Equity: Empowering **Educationally Deprived Learners through Technological Innovations**

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ABSTRACT

This conceptual paper delves into the transformative potential of virtual labs in fostering educational equity, particularly for learners who face socio-economic and geographical barriers to traditional laboratory settings. In an era marked by rapid technological advancement, virtual labs offer a promising avenue for providing access to high-quality educational experiences. Drawing on theoretical frameworks of educational equity and technological innovation, this paper examines how virtual labs can serve as facilitators for empowering educationally deprived learners. By leveraging virtual labs, educational institutions can even transcend physical limitations and provide immersive, interactive learning environments accessible to students regardless of their geographical location or socio-economic status. Virtual labs offer hands-on experimentation and simulation experiences, enabling students to explore complex concepts in STEM (Science, Technology, Engineering, and Mathematics) fields and beyond. Through personalized learning pathways and adaptive technologies, virtual labs can accommodate varying learning styles and levels of proficiency, thereby promoting inclusive education practices.By harnessing the power of technological innovation, virtual labs have the capacity to empower educationally deprived learners, bridging educational gaps, and cultivating a more equitable learning landscape for all students. Hence, this paper recommends for a paradigm shift in educational practices, wherein virtual labs can be embraced as essential components of an inclusive and equitable education system.





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Keywords: Educational Equity, Virtual Laboratories, Empowering Educationally Deprived Learners, Technological Innovations, Inclusivity

INTRODUCTION

In today's rapidly evolving educational landscape, the pursuit of educational equity remains a paramount concern. Despite significant strides in improving access to education, disparities persist, disproportionately affecting learners from underprivileged backgrounds. Socio-economic constraints, geographical isolation, and limited resources continue to hinder the educational opportunities available to many students, exacerbating existing inequalities. Addressing these challenges necessitates innovative approaches that transcend traditional boundaries and empower educationally deprived learners and fostering educational equity. The concept of educational equity underscores the imperative of providing all students with equitable opportunities to succeed, irrespective of their background or circumstances. Yet, achieving this vision remains elusive in the face of persistent disparities in access to educational resources and opportunities. Students from marginalized communities often lack access to well-equipped laboratories, specialized equipment, and expert instruction, limiting their ability to engage meaningfully in hands-on learning experiences. Consequently, these learners are disproportionately disadvantaged in pursuing careers in STEM (Science, Technology, Engineering, and Mathematics) fields and other knowledge-intensive domains. But in order to compete globally, students require a strong foundation in science, technology, engineering, and mathematics (STEM). It is critical for students to compete globally, drive innovation, contribute to national development goals, enhance global competitiveness, improve quality of life, and address strategic priorities. By prioritizing STEM education, India can empower its youth to realize their full potential and contribute to the realization of Viksit Bharat. Amidst this backdrop, technological innovation has emerged as a potent force for transformative change in education. To this end, the development and evaluation of educational innovations in science classes have become increasingly significant (Oser, 2013). One major outcome stemming from the evolution of the digital age that finds relevance in education is the emergence of virtual laboratories (Irwanto, 2018). These platforms provide stimulating lab simulations, intuitive tool interfaces, and heightened accuracy in results.

Virtual laboratories are attracting attention for their potential to democratize the availability of high-quality practical educational experiences. These computer-based simulations of laboratory experiments are gaining popularity in science education due to their ability to enhance learning outcomes and engage students (Asare et al., 2023). Additionally, in science classrooms, students engage in hands-on learning experiences that facilitate effective comprehension and long-term retention of knowledge, allowing them to connect it with real-life situations. While traditional science instruction often takes place in physical laboratories, the advancement of information technologies has led to the utilization of virtual laboratories. Virtual laboratories serve as supplementary resources that simplify the teaching and learning process (Durkaya, 2023). These virtual learning environments let students plan and carry out a lot of studies in a short period of time with minimal help from the teacher (De Jong et al., 2023). If the research site is geographically inaccessible or the material or equipment is expensive, virtual investigations can also be a good substitute for physical investigation (Hannel and Cuevas, 2018). Therefore, in this context, virtual labs offer a compelling solution to the challenges of educational inequity. By leveraging digital technologies, virtual labs provide students with access to simulated laboratory environments, enabling them to conduct experiments, explore scientific concepts, and engage in inquiry-based learning activities. Moreover, virtual labs transcend geographical barriers, making high-quality educational resources accessible to students in remote and underserved areas. This democratization of access holds the potential to ensure equity and narrow the educational gaps that persist between privileged and marginalized or educationally deprived learners. By providing immersive, interactive learning environments that transcend physical constraints, virtual labs offer a promising avenue for fostering educational equity. Given this context and by examining theoretical frameworks and reviewed literature, this paper elucidates the role of virtual labs as facilitators for fostering inclusive and equitable education practices thereby advancing the agenda of educational equity. Also, through a critical analysis of the opportunities and implications associated with





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virtual labs, this paper endeavours to inform educators, policymakers, and stakeholders about the use of technological innovation in creating a more equitable learning landscape for all students.

EDUCATIONAL EQUITY

Educational equity remains a central concern in contemporary education systems worldwide, as persistent disparities in access, opportunity, and outcomes continue to hinder the realization of fair and equitable educational experiences for all students. Educational equity encompasses the fundamental principle of ensuring that all individuals, regardless of their background or circumstances, have equitable access to the resources, opportunities, and support needed to achieve academic success and reach their full potential. It entails providing fair and equal access to high-quality education, inclusive learning environments, and personalized support services. This includes addressing systemic barriers and disparities that disproportionately affect certain groups of students, fostering inclusive practices that celebrate diversity and promote a sense of belonging, and holding educational institutions accountable for ensuring that every student has the opportunity to thrive academically, socially, and emotionally. By prioritizing educational equity, we strive to create a more just and inclusive society where every individual has the opportunity to succeed and contribute to the betterment of their communities.

EDUCATIONALLY DEPRIVED LEARNERS

"Educationally deprived students" refers to individuals who face significant barriers or challenges that hinder their access to quality education and impede their academic progress. These barriers can be due to various factors, including socio-economic disadvantage, limited access to resources and support, inadequate educational infrastructure, discrimination, language barriers, disabilities, or other personal or systemic challenges. Educationally deprived students often lack access to essential learning opportunities, such as high-quality instruction, educational materials, technology, extracurricular activities, and support services, which can hinder their academic achievement and overall educational outcomes. Addressing the needs of educationally deprived students requires targeted interventions, resources, and support systems to mitigate the impact of their disadvantages and ensure equitable access to educational opportunities, enabling them to overcome barriers and reach their full potential.

ROLE OF TECHNOLOGY IN ADDRESSING EDUCATIONAL INEQUITIES

Technology possesses immense potential to revolutionize the educational landscape. It has the capacity to strengthen the bonds between educators and students, reshape our methodologies for learning and cooperation, diminish historical disparities in accessibility and fairness, and tailor learning encounters to accommodate the diverse needs of every learner. The advancement of technology plays a pivotal role in addressing educational equity by providing tools and resources to bridge the gap between privileged and marginalized students. Technology facilitates equitable access to education by breaking down geographical barriers through online learning platforms, enabling students from underserved communities to access high-quality educational resources and instructions regardless of their location. Additionally, technology offers personalized learning opportunities tailored to individual students' needs, abilities, and learning styles. Digital tools and resources, such as virtual laboratories, educational apps, and interactive multimedia content, enhance engagement and comprehension, particularly for students with diverse learning needs or language backgrounds. Moreover, technology enables educators to track student progress more effectively, identify areas of need, and provide timely interventions, thereby reducing disparities in academic achievement. Overall, the strategic integration of technology in education holds immense potential to promote educational equity by democratizing access, enhancing learning outcomes, and empowering all students to succeed academically and beyond.

VIRTUAL LABORATORIES

Virtual laboratories, often abbreviated as "virtual labs," are digital environments or simulations that replicate the functions and experiences of traditional physical laboratories but in a digital format. These virtual environments allow users, typically students and researchers, to conduct experiments, explore scientific concepts, and perform simulations without the need for physical equipment or materials. Virtual laboratories can take various forms and may encompass different disciplines, including physics, chemistry, biology, engineering, computer science, and





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more. They utilize computer software, interactive multimedia, and sometimes virtual reality technology to create immersive learning experiences.

Key components of virtual laboratories may include

Simulations

Virtual laboratories often include simulations that mimic real-world phenomena or experiments. These simulations allow users to interact with virtual objects, observe outcomes, and analyze data in a controlled digital environment.

Remote Access

Some virtual laboratories offer remote access to physical laboratory equipment and instruments, allowing users to control experiments and collect data over the internet. This feature enables distance learning and collaborative research opportunities.

Interactive Multimedia

Virtual laboratories may incorporate interactive multimedia elements such as videos, animations, graphics, and interactive tutorials to enhance the learning experience and reinforce scientific concepts.

Customization

Users may have the ability to customize experiments and parameters within virtual laboratories, enabling them to explore different scenarios, variables, and outcomes based on their interests and learning objectives.

Feedback and Assessment

Virtual laboratories often provide feedback mechanisms and assessment tools to evaluate users' performance, understanding, and mastery of scientific concepts. This may include automated grading, real-time feedback, and performance analytics.

Accessibility

Virtual laboratories offer the advantage of accessibility, allowing users to access learning materials and conduct experiments from anywhere with an internet connection. This accessibility makes virtual labs particularly valuable for remote learning, distance education, and self-paced study.

VIRTUAL LABS: BRIDGING GAPS AND FOSTERING EQUITY IN EDUCATION

In the realm of education, there exists a number of students who face challenges in accessing physical laboratories to conduct experiments firsthand. These students have a deep desire to engage in hands-on scientific exploration but are constrained by the lack of available resources. For these students, the inability to access physical laboratory settings is not merely an inconvenience; it is a profound injustice that threatens to dim the flames of their academic aspirations. However, in the midst of this adversity, there is a light of possibility that shines forth from the realm of virtual laboratories. Through these digital labs of scientific inquiry, students deprived of access to traditional lab settings find solace and opportunity. In this vast realm of the digital world, they are free to explore, experiment, and discover without the constraints of physical limitations. With a click of a mouse and a keystroke, they traverse the frontiers of scientific knowledge, conducting experiments, analysing data, and unravelling the mysteries of the natural world. Though they may be physically distant from the traditional laboratories, in spirit, they stand shoulder to shoulder with their peers, united in their pursuit of scientific understanding. Through the transformative power of virtual laboratories, these students are not merely spectators of science; they are active participants, empowered to engage, explore, and excel on their educational journey. Overall, virtual laboratories serve as powerful educational tools that provide students and researchers with hands-on learning experiences, promote experimentation and inquiry-based learning, and facilitate access to scientific knowledge and skills in a digital format. They play a crucial





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role in modern education, particularly in fields where access to physical laboratory facilities may be limited or impractical.

Points further highlighting that how virtual labs benefit the learners

- Equitable Access: Educationally deprived learners often lack access to physical laboratory settings due to
 factors such as geographic location, limited resources, or school infrastructure. Virtual labs provide these
 learners with equitable access to hands-on experimentation and scientific exploration, regardless of their
 circumstances.
- 2. **Empowerment and Confidence Building:** By providing educationally deprived learners with opportunities to actively engage in scientific inquiry and experimentation, virtual labs empower them to take ownership of their learning and build confidence in their abilities to succeed in STEM disciplines.
- 3. **Cost-effectiveness:** Traditional laboratory equipment and materials can be expensive and may be inaccessible to students from disadvantaged backgrounds. Virtual labs eliminate the need for costly resources, making it more affordable for educationally deprived learners to engage in scientific experiments and activities.
- 4. **Safety:** Virtual labs offer a safe learning environment where learners can conduct experiments without the risk of injury or exposure to hazardous materials. This is particularly important for students who may not have access to properly equipped or supervised physical laboratories.
- 5. **Flexibility:** Virtual labs offer flexibility in terms of time and location, allowing learners to access educational resources at their own convenience. This flexibility is beneficial for educationally deprived learners who may have competed responsibilities or limited access to transportation.
- 6. **Interactive Learning:** Virtual labs provide interactive and engaging learning experiences, allowing learners to manipulate virtual equipment, observe outcomes, and analyze data in real-time. This hands-on approach enhances comprehension and retention of scientific concepts, particularly for learners who may struggle with traditional instructional methods.
- 7. **Personalized Instruction:** Virtual labs can be tailored to meet the individual needs and learning styles of educationally deprived learners. Educators can design virtual experiments that align with students' interests, abilities, and learning goals, providing a more personalized and engaging learning experience.
- 8. **Supplemental Resources:** Virtual labs can serve as valuable supplemental resources to complement traditional classroom instruction. They offer opportunities for independent exploration and reinforcement of concepts, allowing learners to review material at their own pace and depth.
- 9. **Bridge the Digital Divide:** While access to technology may be limited for some educationally deprived learners, efforts to increase access to virtual labs can help bridge the digital divide by providing opportunities for technology integration and d Immediate Feedback and Remediation: Virtual labs often include built-in feedback mechanisms that provide immediate guidance and support to learners as they conduct experiments. This allows educationally deprived learners to receive real-time feedback on their performance and address misconceptions or gaps in understanding promptly.igital literacy development.
- 10. **Overcoming Physical Limitations:** For learners with disabilities or health concerns that prevent them from participating in traditional laboratory settings, virtual labs offer an accessible alternative. These learners can engage in scientific experimentation and exploration without encountering physical barriers or limitations.
- 11. **Lifelong Learning Opportunities:** Virtual labs can be accessed beyond the confines of formal education, providing educationally deprived learners with opportunities for lifelong learning and skill development. These learners can continue to explore scientific concepts and pursue their interests in STEM fields outside of traditional classroom settings.
- 12. **Collaborative Learning Opportunities:** Virtual labs can facilitate collaborative learning experiences among educationally deprived learners, allowing them to work together on experiments, share findings, and collaborate on projects regardless of geographical distance or physical proximity.

Overall, virtual labs play a crucial role in empowering educationally deprived learners by providing equitable access to hands-on learning experiences, fostering engagement and comprehension of scientific concepts, and promoting inclusion and accessibility in science education. However, realizing the full potential of virtual labs as facilitators for educational equity requires careful consideration of various factors. Challenges such as the digital divide, technical





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infrastructure limitations, and pedagogical integration issues must be addressed to ensure equitable access and meaningful engagement for all learners. Moreover, the effectiveness of virtual labs in promoting learning outcomes and fostering equitable educational experiences demands availability of resources, training, rigorous examination, and evaluation.

RECOMMENDATIONS

- ✓ Policymakers, educators, and stakeholders can work together to harness the potential of virtual labs as facilitators for educational equity, empowering educationally deprived learners through technological innovation.
- ✓ Digital inclusion initiatives must be taken to encourage programmes designed to close the digital gap and increasing access to technology for educationally deprived learners. This includes providing financial aids for internet access, e-gadgets, and software licenses, as well as offering training programs to improve digital literacy skills.
- Educational policies should encourage the integration of virtual labs into curriculum frameworks at all levels of education. This includes providing guidelines and standards for incorporating virtual labs into the curriculum to ensure their effective usage as tools for promoting educational equity.
- ✓ Policymakers should invest in training programs and professional development opportunities for educators to enhance their skills in integrating virtual labs into teaching practices. This includes providing workshops, online courses, and certification programs to ensure that teachers are proficient in using virtual lab platforms and pedagogical approaches.
- ✓ Stakeholders in the field of education must be engaged in virtual labs adaptation trainings and workshops so that they can be equipped with necessary skills for adaptation of virtual lab platforms in their classroom practices.

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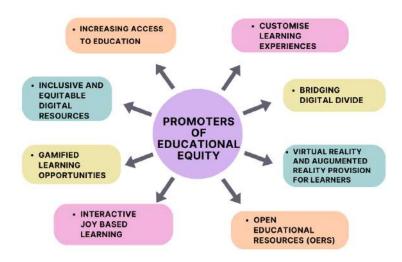


Figure 1: showing the promoters of Educational Equity





REVIEW ARTICLE

Exploring Menstrual Management Awareness and Challenges for Adolescents with Intellectual Disabilities and Their Mothers/Caregivers: A Literature Review

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ABSTRACT

With an emphasis on the knowledge and experiences of mothers or caregivers, this review article delves into the intricacies and difficulties of menstruation management in teenagers with intellectual disabilities. The paper begins by contextualizing the issue within the broader framework of menstrual health and hygiene management (MHM), underscoring the additional challenges faced by this specific group. A systematic review of existing literature reveals a significant gap in knowledge and resources available to these adolescents and their caregivers. The review paper synthesizes studies that detail the physical, emotional, and social challenges encountered during menstruation by adolescents with intellectual disabilities. These challenges are further compounded by societal stigmas and a lack of tailored educational resources. Additionally, the review highlights innovative approaches and best practices in MHM for this demographic, including adaptive menstrual products, specialized educational programs, and community support initiatives. The role of healthcare professionals and educators in providing accurate information and support is also examined. The paper concludes by emphasizing the need for more inclusive and accessible menstrual health education and resources. It calls for broader societal engagement to remove the stigma surrounding menstruation and intellectual disability. The review suggests that empowering mothers and caregivers through education and enhancing the menstrual health experiences of teenagers with intellectual impairments requires help. This abstract provides a concise overview of the paper's content, methodology, findings, and recommendations, tailored to the topic of menstrual management for the parents of teenagers with intellectual disability.

Keywords: Menstrual Management, Adolescents, Intellectual Disability, Awareness, Mothers, Caregivers.





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INTRODUCTION

The menstrual cycle, a crucial aspect of female reproductive health, is often discussed in sexual education but not as much attention is given to the experiences and challenges experienced by moms or caregivers of teenagers with intellectual impairments (ID). These teens face unique challenges in managing their menstruation, necessitating specialized care and a tailored strategy to protect their physical and mental health [1]. Adolescents with intellectual disabilities experience particular difficulties during menstruation because of the cyclical nature of the menstrual cycle and their dependence on caregivers for everyday hygiene duties. Conditions like polycystic ovarian syndrome, thyroid disease, and epilepsy can create anomalies in the menstrual cycle, making managing menstruation even more challenging [2]. Related disabilities that could increase risk include cerebral palsy and vision or speech impairment. Menstrual discomfort can exacerbate behavioural manifestations like tantrums, crying fits, and self-abusive behaviors, which can make maintaining menstrual hygiene more difficult for some adolescents with intellectual disabilities [3]. Teens with significant intellectual disabilities may also be non-ambulant and incontinent (WHO, 1985), which could complicate the caretaker's duties by making managing menstrual hygiene even more difficult. Teenagers with intellectual disabilities (ID) often face challenges in managing their menstrual cycle due to fear, worry, and embarrassment due to a lack of knowledge and education. Carers also face unique challenges in assisting their kids through the menstrual cycle, making menstrual management even more complicated when parents struggle to provide necessary resources and assistance [4]. The review aims to evaluate the awareness and understanding of menstruation among adolescents with intellectual disabilities, identify challenges faced by mothers and caregivers in managing menstruation, and assess the effectiveness of existing support systems and resources.

METHODOLOGY

Search strategy

The study aimed to find peer-reviewed publications on MHM and disability, covering all nations and no time constraints. The searches were conducted between 2014 and 2024 using four online databases: PubMed, Scopus, MEDLINE, and Web of Science. A thorough examination of reference and internet searches identified pertinent studies. The search terms encompassed three essential ideas: disability, menstruation, and hygiene management. The category encompassed both precise disabilities and comprehensive evaluations, such as self-reported limitations in functioning or activities.

Criteria

Inclusion criteria

Research on menstrual management awareness and challenges for adolescents with intellectual disabilities, including mothers and caregivers, is crucial. It should explore experiences, perspectives, and challenges faced during menstruation, discuss strategies, interventions, and support systems, and be peer-reviewed, conducted in diverse locations, and published in English.

Exclusion criteria

Research on menstrual management, especially for adolescents with intellectual disabilities, often lacks perspectives from caregivers and mothers and is sourced from non-academic sources. Inadequate methodological rigor, insufficient data, and articles lacking relevance to research objectives are also considered. Literature published before 2014 ensures relevance to current practices.

Study selection

The study was searched, duplicates removed, and titles, abstracts, and key words double-screened by two authors. Using inclusion criteria, full-text records of pertinent publications were gathered and vetted. The last group of research was selected, and the results were compared and contrasted. The process ensured eligibility and accuracy in the systematic review.





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Data extraction

Findings should fill in any gaps in the socio-ecological framework for managing menstrual hygiene (MHM) for persons WITH disabilities and their caregivers. Using the socio-ecological framework and pre-designed tables, data was retrieved from chosen research. Although the review did not perform a meta-analysis because of inconsistencies in study designs and results, it did adhere to the PRISMA statement's standards.

Quality assessment

The study utilized Banks et al.'s approach to evaluate potential bias in studies, using modified tools STROBE and RATS for both quantitative and qualitative studies. The emphasis was placed on potential biases arising from several aspects such as study design, sampling procedures, data collecting, analysis, and interpretation. The risk of bias evaluation was conducted using an overall approach, categorizing studies as low risk if they fulfilled all criteria, medium risk if they fulfilled some criteria, and high risk if they fulfilled few or no criteria.

RESULTS

Study selection

A total of 8029 records were found during the database searches. Three more records were obtained using the authors' expertise in the existing literature. A total of 2899 duplicates have been identified and successfully eliminated. In the title screening process, an additional 4280 studies were excluded, followed by the exclusion of 815 records through abstract screening. A total of 35 full text articles were evaluated, with 13 being excluded. We included all 22 studies that were left. Fig. 1 shows that no more studies were found through database alerts.

Summary of research investigations

In the majority of the 22 studies, disabled people (n = 13; 59%) were the primary participants, followed by the career (n = 6; 27%), or both the career and the disabled person (n = 3; 14%). The participants were recruited from a variety of sources, including households (n = 6; 27%), institutions (n = 13; 59%), and a mix of households and institutions (n = 3; 14%). A variety of techniques were employed to assess impairment, including as government listings (n = 2; 9%), self-reported measures (n = 4; 18%), and clinical assessments (n = 8; 36%). Seventeen studies (77%) looked at people with intellectual disabilities, three studies (14%) looked at people with different kinds of impairments, and two studies (9%), looked at people with physical impairments. 13 studies (59%) were categorized as having a low risk of bias, seven studies (32%) as having a medium risk of bias, and two studies (9%) as having a high risk of bias, according to the quality evaluation. The main causes of possible bias were the limitations on the findings' generalizability brought about by a small sample size and a response rate that was lower than 70%.

Impacts of menstruation

Premenstrual syndrome and communication challenges faced by individuals with intellectual disabilities

Nine publications (41% of total) addressed PMS [5][6][7][8][9][10][11][12][13]. Intellectually disabled people may experience PMS symptoms and behaviors like menstrual cramps, mood fluctuations, exhaustion, agitation, hostility, social disengagement, impaired focus, heightened hyperactivity, self-harm, and inappropriate handling of sanitary goods or menstrual blood [6] [7][8][9][10][11][12][13]. Six studies assessed pain occurrence and intensity [8][9][10][11][12][13], with three comparing disabled and non-disabled people [9][10][13]. Obaydi and Puri [10] found that 92% of autistic people had PMS, compared to 11% of non-disabled controls. The least biased study was this one. Kyrkou [9] found that Down syndrome and autistic patients are more uncomfortable than others. Due of the difficulty of communicating pain intensity and location, Kyrkou deduced it from behavior changes. This discovery was contradicted by Ibralic et al. [13] and Ranganath & Ranganath [11]. Ibralic et al. discovered that both those without intellectual disabilities and those with disabilities shared the same prevalence of PMS symptoms. Down syndrome patients reported no menstrual discomfort or premenstrual tension, according to Ranganath & Ranganath. The authors did not assess or analyze individuals' communication skills. Ranganath and Ranganath's study was





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potentially biased. Three studies compared PMS symptoms by handicap type [6] [9][12]. All studies show group variation or disagreement. Kyrkou [9] and Hamilton et al. [12] recognized the importance of pain expression. Kyrkou found that 67% (n = 8) of intellectually impaired Down syndrome patients could convey their discomfort or indicate where they were suffering, despite poor speech skills. Although all nine autistic individuals had good language skills, only one could point to or announce her suffering. Three studies found that intellectually disabled people who couldn't understand or communicate pain had altered behavior [6] [7].

Challenges pertaining to caretakers of individuals with intellectual disabilities

Six studies (27%) investigated the main worries of caregivers for people with intellectual disabilities [6][7][8][9][14][15]. In Thapa and Sivakami's [7] study conducted in India, carers (namely mothers) of individuals with intellectual impairments highlighted that communication difficulties between them and their children were a significant obstacle. Mothers face difficulties in communication, which causes them to depend on watching alterations in their daughter's behavior as a means of predicting menstruation [6]. Indicators encompass irritability, restlessness, sobbing, self-harm, reduced food, and disturbances in sleep patterns [6]. Additional difficulties noted by carers included a strong dislike for using period products, a failure to follow social and cultural norms, such as not changing used menstrual items in public, discussing one's period with others, or properly managing menstrual blood and products [7]–[9]. One of the six researches examined the satisfaction levels of professional carers with intimate care chores. It was found that, after giving enemas, menstruation care was the second-least favorite task for residential staff. Furthermore, it was demonstrated to be the feature that day unit staff members, who do not do enemas, detested the most [14].

Methods for managing menstrual hygiene effectively

Acceptability of menstrual products for individuals with physical disabilities

Four research (18%) looked at the preferred and used menstruation product [6] [7][16], [17]. Two of these studies examined the product utilised [16], [17]. The acceptability of the product from the standpoint of people who have spinal cord injuries was investigated in one study, while caregivers' preferences were the subject of the other two. A considerable proportion of the subjects in the research, which focused on Americans with spinal cord injuries, reported difficulties in properly situating menstruation products to ensure maximum absorbency. They also experienced escalating challenges with catheters and controlling their urine during menstruation.

Acceptability of menstrual products for individuals with intellectual disabilities

Of the 22 investigations, three looked at the preferences of people with disabilities with the help of caregivers [6][7][17]. According to the studies, people with intellectual disabilities often refused to use menstruation products, which put a strain on caregivers and necessitated constant compromise with the impaired person.

In an Indian research, mothers limited their daughter's physical activity when she was menstruating to keep her from wearing blood-stained garments outside [7]. Another tactic used by caregivers in Taiwan was to buy adult-sized diapers for their daughters or sew the pad inside the underwear [6]. Moms were taking care of incontinent daughters in two of the four research [6][7]. Caregivers voiced concern about the high cost of diapers and pads and the added complexity that menstruation brought.

Services offered by MHM to individuals with intellectual disabilities, including training and support

Training in MHM for persons with intellectual disabilities was the subject of five studies, or 23% [7], [9][17][18][19]. This group received inadequate training and support due to careers' doubt in their ability to understand MHM knowledge, according to a study. The authors hypothesized that people with intellectual disabilities may not use menstrual products due to a lack of Menstrual Hygiene Management (MHM) education, including information on products and the chance to try them before their first period. As a result, they didn't understand menstrual products, felt uncomfortable using them, and related them to period pain. One of these five studies studied institutional menstrual hygiene management (MHM) teaching for intellectually disabled people [19]. The study found no





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correlation between training and comprehension. Three studies found that intellectually disabled people who received menstrual hygiene management (MHM) instruction were better able to control their periods [7], [9][19]. Down syndrome patients in Australia and New Zealand who were given MHM knowledge before to puberty had an easier time controlling their periods, according to Kyrkou's research. Altundağ and Calbayram [18] discovered that menstrual hygiene management for intellectually impaired individuals in Turkey was significantly improved when they were shown how to use a doll to mimic changing and disposing of old menstrual items.

Training and assistance provided to carers for Menstrual Health Management (MHM)

Five studies looked at how much support and training moms and other caregivers received to help people with intellectual disabilities manage their menstrual cycles [6] [7][14][20][21]. Three of the aforementioned research [20], [21] [14]examined professional carers employed in institutional settings, while two studies [6] [7]focused on mothers who were caring for their children at home. The three institutional studies that looked at MHM training and standards for personal and intimate care found that they were lacking. The significance of these tasks was not fully acknowledged by management. Intellectually disabled people lacked knowledge about menstruation and received less help with menstrual problems than sex education but more help at menopause [20], [21] [14]. The mothers in the two studies examining familial care were not provided with any direction, information, or support about the management of their daughter's menstruation. Consequently, they experienced feelings of being overwhelmed and lacking support [6]. In both Indian and Taiwanese cultures, mothers consider menstruation to be a personal matter and therefore refrain from discussing their daughter's menstrual cycle with anyone, including experts [6] [7].

Menstrual suppression

Six papers explored menstruation suppression in intellectually disabled people [6] [7], [8] [22][23] [24]. Hysterectomy, tubal ligation, and long-term contraceptives like the pill and patch are used to suppress menstruation. Two of the six investigations were in LMICs and four in HICs [7], [24]. Two studies [24][23] were published before 2000, while four were published after 2010 [6] [7], [8][22]. Five of the six articles reported sterilization or long-term contraception for intellectually disabled people. Caregiver reasons for sterilization include viewing menstruation care as burdensome, concerns about unwanted pregnancies [7], [8][22]–[24], challenges with managing menstrual care tasks, the idea that menstruation has no positive effect on persons with intellectual impairments, and mothers' preference to relieve older daughters of menstrual care when they are no longer able to do so [7], [24][22]. Three studies assessed caregiver satisfaction after sterilization [7], [24][22]. They all reported high caregiver satisfaction. Taiwanese researchers questioned menstruation suppression [6]. This study found that regular menstruation indicated physical health. Girls with intellectual disabilities were medicated to manage their cycles. But almost all of the moms in this study heard from friends, family, and doctors that sterilizing their daughters would help with hygiene, menstruation care, and preventing unwanted pregnancies [6].

DISCUSSION

The majority of the 22 studies that addressed the issues of people with disabilities in terms of menstrual hygiene management (MHM) concentrated on those with intellectual impairments and those who care for them. Because of cultural taboos and prejudices, menstruation and disability are not openly discussed, and resources are not allocated adequately. It is challenging to advocate for more attention and funding to meet the MHM needs of people with disabilities and their caregivers due to the dearth of peer-reviewed research in this area. Some people with disabilities and their caregivers struggle to cope because there is a shortage of appropriate MHM training, information, and support tailored to their requirements. During menstruation, caregivers may employ ways to control the flow of blood or limit their mobility. The primary box in Fig 2 is dedicated to individuals with intellectual impairments. Based on the review, it has been observed that individuals with intellectual impairments may sometimes struggle to comprehend or adhere to social and cultural norms [7]–[9], [15], as well as face challenges in using menstrual products [6], [7]. This group encounters difficulties in comprehending PMS and expressing their discomfort [5]–[13]. Carers reported that the behaviors related to menstruation caused them stress and





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embarrassment. As a result, they would prevent their daughters from leaving the house or try to find ways to manage and reduce their menstrual symptoms [7]. Individuals with intellectual disabilities may benefit from improved period management and greater autonomy if they get accessible menstrual hygiene management (MHM) information and training on a regular basis. This will help them better comprehend cultural and social standards. Figure 2's bottom box highlights how the facilities studied lacked both criteria and training for menstruation care providers [14], [20], [21], particularly in relation to carers. Research indicates that carers who specialize in providing care services express a strong aversion towards assisting with menstrual care. When these two factors are combined, disabled people in institutional settings may have their dignity and personal cleanliness compromised as a result. The evaluation revealed a dearth of MHM training and assistance for families dealing with daughters who have intellectual disabilities [6]. Also, mothers detest menstruation care [7], [24], [25]. The conventional wisdom held that persons with disabilities should not procreate or engage in sexual interactions, making it difficult for mothers to recognize the positive impacts of menstruation on their daughters [26]. Mothers are hesitant to seek counsel or support due to disability and menstruation taboos. They consider menstruation care personal. Besides Fig 2, the studies explored impaired people's menstruation product preferences [6], [7], [14], [15]. Physically disabled research participants disliked period items like sanitary pads and tampons. They found these items uncomfortable and difficult to use, especially with catheters [16].

Prospects for future investigation

In low and middle income nations, there is a lack of research on the needs of individuals with disabilities when it comes to menstrual hygiene management (MHM). In these settings, defined measures for evaluating MHM outcomes are lacking. Incorporating people with disabilities and their caregivers into a revised socioecological framework for MHM may help with this [27]. This framework acknowledges that MHM outcomes are influenced by individual, societal, and environmental factors, on the target population's menstrual hygiene management (MHM) and their experiences with menstruation. Further investigation is needed to examine the extent of premenstrual syndrome (PMS) in handicapped individuals and among different disability groups. Strategies to empower disabled individuals to identify and express discomfort are also needed. Additionally, studies on the preference and effectiveness of menstruation products for individuals with various impairments are needed to determine their suitability and acceptability in the market.

CONCLUSION

In conclusion, the data that is currently available on MHM for adolescents who have intellectual disabilities and their carers is limited, which highlights a significant need in both understanding and assistance. The failure to resolve this gap contributes to the perpetuation of systemic inequalities and disallows individuals to exercise their rights to health, dignity, and inclusion. In the future, it is absolutely necessary for research and action to give priority to the needs of this marginalized community in terms of MHM. This includes the development of interventions that are inclusive and those respects their rights and promote their well-being. When it comes to the pursuit of menstrual health and dignity, we can only assure that no one is left behind if we work together to achieve this goal.

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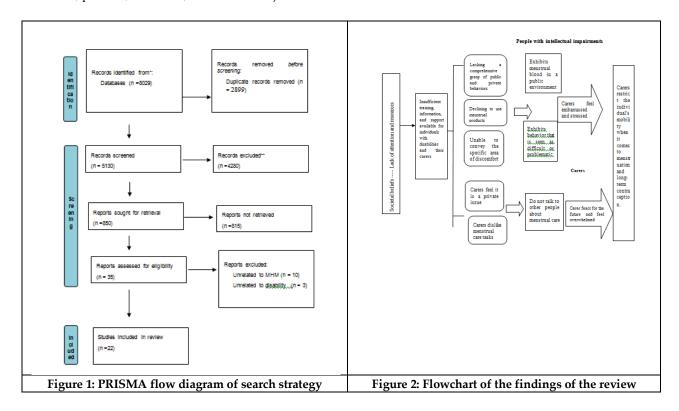
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RESEARCH ARTICLE

Analysis of Network Privacy Security Application Research using Machine Learning and its Applications

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ABSTRACT

The importance of computer networks has grown as science and technology has progressed, particularly with the application of big data technology. Computer networks have had a significant impact on people's lives and work, and have even become ingrained in them. However, while computer system technology has improved people's live, it has also revealed significant flaws. For example, the resulting information security issues endangers people's personal privacy, business security, national security, and so on, posing a threat to computer network technology's long-term development. The supercomputer network security. It is very important to expand study into the issue of computer network information leakage and its causes, as well as computer network security management. Simultaneously, we should take the appropriate preventative measures, both technical and managerial, to ensure the safety of computer network data and reduce computer network dangers. As a result, based on related ideas of computer network information security, this article will examine and study the current variables affecting computer network security. To maintain the security of network information, the author examines how we might increase defences from the perspectives of technology and management.

Keywords: Computer Network, Network safety, Protection Strategy,





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INTRODUCTION

The Internet of Things (IoT) is a wireless network of interconnected smart nodes that communicate with one another to share data. Over the last few years, the Internet of Things has grown in attractiveness, require, and industrial availability. Smart cities, developed enterprises, healthiness institutions, and government are just a few of the sources of data generated by IoT applications. [1-2]Because of the pervasiveness of IoT and the seemingly endless possibilities that it offers, security and privacy have become two major issues for users of these smart services. The majority of privacy vulnerabilities expose private information to unintended parties, posing substantial risks in a variety of IoT applications. As a result, this article will review existing literature on various IoT privacy concerns, privacy challenges in various IoT applications.

Basic Information and Network Security Concepts in Computer Networks

Computer network security is primarily concerned with the protection of network data. That appropriate security preventive and control procedures and technologies are implemented to ensure that users' network environments are safe and secure. We are responsible for ensuring the security of data storage, transport, and use, as well as ensuring that the data is not leaked or corrupted throughout this process. We can also look at it from a physical standpoint. Network security also covers the protection of computer network equipment, software, and hardware from natural and human elements that could cause damage. Information security is one of them. It ensures the completeness and correctness of data. The normal and stable operation of all hardware equipment in the computer network, as well as the safe operation of all software and its legal and reasonable use, is referred to as network equipment security. In general, computer network security ensures that external incursions and attacks do not harm the complete computer network system, including software, hardware, and network information. This is suitable for the computer network system's secure and reliable functioning and can be used routinely.

Computer Network Security

Security Management System for Networks

The inadequacy of associated systems is not enough to cause managers to pay attention to computer network information and the security management of the complete system when it comes to preventing and controlling computer network security management. Managers will not be able to perform the function of network security management if they do not have appropriate security awareness, as well as ineffective management methods and unclear job responsibilities. This exposes the computer network to risks such as computer viruses and hackers, resulting in data loss and network system failure. Computer network equipment, as well as its software and hardware, must be secure in order for computer networks to function normally. If the computer network equipment, including its hardware and software, fails, it will inevitably compromise the overall system's security and cause issues such as information leaking. Security management of network systems and physical equipment is currently lacking, particularly in terms of network equipment computer room environment testing and information transmission medium security inspections[3-4]. Furthermore, when network security administrators set up the network. There are certain irrational characteristics, such as excessive user authority and a lack of application bandwidth management. As a result, users can reach the server without having to open the server port. These actions will provide the appearance of unauthorised access, resulting in user losses and a threat to network security. It's Impossible to Plan a Computer Network Enough Currently, total network security management has not been considered in system planning, nor has it been established from a technological, industrial, or policy standpoint. That is, there is no complete network security system in the overall computer network planning. The network security system isn't backed up by rules, laws, or regulations, and the strategy doesn't even include network security. This will have an impact on the future growth of computer networks as well as the system's routine operation.





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Other Stages of Development

The problems of equipment ageing and electromagnetic radiation damage in computer networks have not been fully resolved, which will have an impact on the implementation of computer network preventive and control activities. At this point. India imports computer network-related technologies from other countries, and there are few mature and self-developed advanced technologies in the country. As a result, residential computer networks are riddled with flaws. When hacker viruses and other breaches occur, network data security is compromised, and the integrity and correctness of the data cannot be guaranteed. In addition, the threat of hacking and viral infection has grown in severity. These types of attacks, as well as hacker attacks, have progressed from individual to organisational levels. The capabilities of numerous viruses and Trojan horses are increasing, and there is a link between the rise in Trojan horse espionage programmes and harmful websites[5]. Although the capabilities of mobile phones and APP development have improved. Wireless terminals have been increasingly targeted by hackers and viruses. And the consequences are becoming more severe. When it comes to the network system's security prevention and control, The network protocol's flaws haven't been addressed, and spam emails can't be properly blocked. Furthermore, incidents such as tampering, eavesdropping, forgeries, and purposeful destruction of data have become more common. Additional Examination of Computer Network Security Threats and Their Causes

Risks to Your Security

Computer Network Phenomenon and Characteristics

Additional Examination of Computer Network Security Threats and Their Causes. Computer Network Security Threats: A Phenomenon and Characteristics .Computer system dangers, network security risks, and network information risks are all examples of computer network security threats[6-10]. Although computer system technology is continually evolving and improving, criminal technology is also evolving and improving. As a result, these criminals can still exploit small flaws in the system to ruin the network, resulting in information leakage, data destruction, and other issues, as well as losses to individuals or businesses. Second, due to the openness, sharing, and complexity of computer networks, the security of computer networks cannot be really assured without the development of new technologies if adequate security defensive measures are not done. For example, requiring authentication solely while logging in is insufficient to maintain the security of a computer network as a whole[11-15]. To combat cyber dangers, we must also employ more advanced technology, techniques, and facilities.

Furthermore, the hard discs or files that contain data in the computer network information are readily damaged, and the computer network's flaws provide an opportunity for hackers and Trojan horses to infiltrate. As a result, computer data is either leaked or destroyed. Compromising the integrity and accuracy of data and information, as well as posing a threat to personal privacy, business security, and national security Furthermore, spam is used to distribute viruses. Misappropriation of data and information, as well as the dissemination of illicit material, will cost users and businesses a lot of money. Information security challenges have become more prominent in the era of big data, and they are characterised by integration, size, leapfrogging, and concealment. Ultra-large-scale data has posed significant hurdles to data processing and management in the era of the Internet of Everything, because information sharing that is not limited by time or geography increases information leakage and influence. In large data piles, all kinds of fake and worthless information is mixed in, which not only hides useful information, but also increases the concealment of cybercrime and makes it difficult to identify cybercrime in real time. Private information can also be obtained illegally by merchants for the purpose of fraudulent propaganda and sales, and personal privacy is difficult to defend. However, if sensitive information from businesses and government institutions is accessed and tampered with, businesses and the country would suffer.

An examination of the factors that contribute to computer network security threats Intrusion and Hardware Destruction

Hardware quality and security are critical to guaranteeing the smooth operation of computer networks. If the hardware is broken or intruded upon, it will have a significant impact on the computer network's operation, possibly paralysing the entire system. Computer hardware flaws, on the other hand, are common in computer networks. For example, electronic radiation leakage can result in the loss of critical network information in a computer network. In





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information communication hardware, there are also issues with transmission line quality. The information may be intercepted during the transmission process due to transmission line flaws, resulting in information leakage, tampering, and loss.

Causes of Computer Network Security Threats Analysis Intrusion and Hardware Destroyment

Hardware quality and security are essential for computer networks to function normally. Damaged and intruded hardware will have a significant impact on the computer network's operation, possibly paralysing the entire system. In computer networks, however, computer hardware problems are common. The loss of crucial network information in a computer network, for example, could be caused by electronic radiation leakage. In information communication hardware, there are also concerns with transmission line quality. Information can be intercepted during transmission due to transmission line flaws, resulting in data leakage, tampering, and loss.

The Operating System of the Computer Is Not Sound

The operating system is used by the user to obtain network connectivity. The operating system is used by the user to establish a network connection and to carry out numerous tasks. The security of the computer network cannot be guaranteed if the operating system and operating environment are not flawless, and the entire network will be unstable[16-20]. The following are the major flaws in today's computer operating system: the core technology is rather outdated, and the fundamental technology is imported from another country. India ability to conduct autonomous research and development must be improved. Furthermore, the computer network environment is extremely complicated, with several influencing aspects, and there is still a problem with operational errors. As a result, we are unable to guarantee the quality of the computer operating system, posing a risk to the computer network's overall security.

Threat of Virus

The invasion of numerous viruses and Trojan horse programmes is another key element that puts computer network security at risk. Computer networking technology has progressed. The speed with which network data information is transmitted is increasing, but it also provides the virus with more opportunities to infiltrate the system. Alternatively, the advent of new viruses makes virus transmission Easter, intercepting and eliminating the virus.

Evaluation of Computer Strengthening Measures

Protecting network security and ensuring network information security

Raise the level of firewall technology

The firewall security technology is a computer hardware or software that consists of an analyzer and a limiter and is installed on the computer hardware. This technology is mostly used in network security defence to successfully secure users' access to web sites. This technology safeguards the information system's security by constructing a security defensive firewall that detects and intercepts viruses and Trojan horses in real time, as well as providing users with a secure network environment. Due to the advancement of virus penetration capabilities, we must continually increase the firewall's protection level and establish scientific settings in order to maintain information security and normal use. Packet filtering firewalls, monitoring firewalls, distributed firewalls, and embedded firewalls should all be used to their full potential. Furthermore, we should do data categorization and deeper monitoring in order to achieve real-time dynamic monitoring of the network's internal and external environments and to detect problems in the information storage, transmission, and usage processes as soon as possible. This also aids users in comprehending information access in order to avoid and control the entire computer network system.





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Improve and Modernize Encryption Technology

In the context of big data, encryption settings for data storage and transport are also useful defences. Encryption settings for sensitive information and files can help to limit the risk of data theft. Through information coding, this method is mostly employed to conceal crucial information. This technology can not only secure user data and information, but it can also increase the security of data transfer. Node encryption, link encryption, and closure encryption are all common encryption techniques. Node encryption, for example, refers to the employment of encryption hardware to create a secure function for encrypting data. Setting up equivalent passwords across network nodes to ensure the security of information transfer between nodes is known as connection encryption. To ensure that the information is not tampered with or corrupted during transmission, it is encrypted before being transmitted and then decoded once it reaches the node. End-of-line encryption is the process of encrypting data after it enters a computer network and decrypting it while it is being transmitted.

Improve Technology for Identity Verification

The purpose of identity verification technology is to ensure that network users are who they claim to be. Only users who pass the verification will be able to view a certam webpage or file; otherwise, the machine will be restricted or shut down. Identity verification technology combined with audit trail technology can assure the security of computer data storage and use while also preventing bad actors from infiltrating computer networks. As a result, the entire computer network system's security can be successfully undermined.

Take Advantage of Cloud Computing and Block chain Technology's Benefits

Cloud computing has a high level of virtualization, a high level of stability, and a wide range of adaptability. It has the potential to provide users with a more secure network environment. Furthermore, cloud computing technology is flexible and convenient to use, with a big storage capacity that efficiently protects users' privacy. In the meanwhile, cloud computing works in tandem with data encryption, identity verification, and access controls to improve network security.P2P technology, asymmetric technology, consensus wit, and other technologies are all incorporated into block chain technology. It offers open consensus, traceability, and programmability, as well as decentralisation, anonymity, and non-tamperable data. It solves the problem of third-party and information wit being unable to meet the user's high-sensitive privacy data inclusion criteria and large-scale cross-domain access authentication needs under scattered settings.

Create an Intelligent Information Detection System

Security Concerns

Constructing a comprehensive user online behaviour management system to achieve intelligent network management may not only automatically filter undesirable web pages and applications, but also create audit trails of various data to provide a secure information environment for Internet access. The intelligent system for identifying information security problems in the network can automatically identify security problems in the network and alert the suspected intrusion through behaviour analysis, avoiding the user's attention. It can also intelligently analyse security issues and quickly understand the vulnerable modules of the system, allowing targeted attacks to be carried out. This is extremely beneficial in terms of preserving labour and material resources, boosting the efficiency and efficacy of information security restoration, and lowering business and individual losses.

CONCLUSION

In conclusion, the rapid growth and popularisation of computer network technology has ultimately resulted in network security concerns while providing users with ease. How to secure the safety of data in storage, transmission, and usage, as well as the safety and stability of the overall computer network system, is currently the top issue for study and research in the face of vast amounts of data and information. Because of the openness and complexity of the computer network, it is simple to be "invaded" by viruses, hackers, and other malicious software, which destroys





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the software and hardware in the system and causes data to be tampered with and damaged. As a result, computer network security management must become more important. We can use advanced protection technologies and measures, set up a comprehensive safety management system, and increase user and manager safety awareness, among other things, to reduce the risk of virus hacker intrusion and network data damage, ensuring the normal operation of computer network systems. In practise, we should conduct more research on network security concerns, then build and optimise suitable security defences, and improve the functionality of various defence technologies. Only in this manner will computer network security steadily improve, and the computer industry will be able to achieve long-term, stable growth. Under the Information Environment, an examination of computer network security technology and preventive measures

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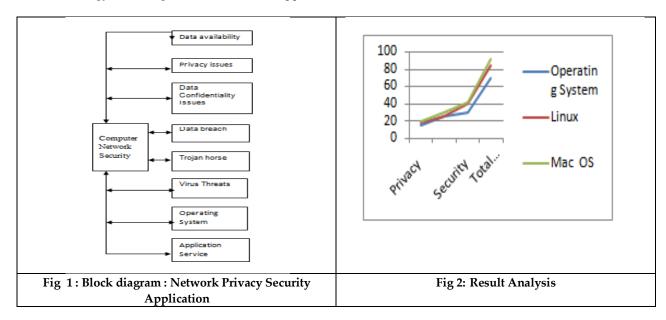
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RESEARCH ARTICLE

Effect of Structured Teaching Programme on Knowledge Regarding Methicillin-Resistant Staphylococcus aureus (MRSA) Infections among **Nursing Students**

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ABSTRACT

Methicillin-Resistant Staphylococcus Aureus (MRSA) Infection has become more common and is a major global health concern, particularly in India. Resistance to Methicillin the bacterium Staphylococcus Aureus is responsible for infections in several body parts. Because it is resistant to several widely used antibiotics, it is more difficult to treat than other strains of Staphylococcus aureus, or staph. 1) To assess the level of pre-test and post-test knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd year B.Sc Nursing students.2) To assess the effect of Structured Teaching Programme on knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd Year B.Sc. Nursing students. 3) To determine the association between pre-test knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection with the selected demographic variables. The research approach and design adopted for this study is quantitative pre-experimental one group pre-test post - test design. The study was conducted at Faculty of Nursing, AdtU among 2nd year B.Sc. Nursing students. 52 nos of 2nd year BSc N students were selected by using non - probability purposive sampling technique. The tools used in the study were socio demographic proforma to collect the baseline demographic information and the Structured knowledge questionnaire (Total no. of items were 20) were used to find out the knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection. Descriptive and Inferential statistics were used to analyse the data. The frequency and percentage was calculated to assess the knowledge of the students Results revealed that 31(59.62%) students pre-test had moderately adequate knowledge and 21(40.38%) had inadequate knowledge





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whereas in the post-test after the Structured Teaching Programme, 46(76.67%) had adequate knowledge and 6(11.54%) had moderately adequate knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection. Pre-test mean with standard deviation was 11.75±3.10 and post-test mean and standard deviation was 22.98±2.19 using paired't' test (t=22.159 at p< 0.0001). Structured Teaching Programme was effective in improving the knowledge of students regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection. It also reveals that there is a significant association between pre-test knowledge score with the selected demographic variable of age. Thus, STP must be regularly included as a part of teaching learning for the nursing students.

Keywords: Effectiveness, Structured teaching programme, Methicillin Resistant Staphylococcus Aureus (MRSA) Infection, 2nd year B.Sc. Nursing students.

INTRODUCTION

Certain staphylococcus strains, such as MRSA, have developed resistance to antibiotics that used to kill them over time. The first strain of Methicillin-resistant Staphylococcus aureus was identified in 1961. It is now resistant to methicillin, penicillin, amoxicillin, oxacillin and other common antibiotics known as cephalosporins. While some antibiotics still works, Methicillin Resistant Staphylococcus Aureus is constantly adapting. Researchers developing new antibiotics are having a tough time keeping up. [1] According to the Centre of Disease Control and Prevention (2020), it estimates that MRSA infection is responsible for more than 70,000 severe infections and 9,000 deaths per year.[2] After years of progress, the rates of decline of Methicillin Resistant Staphylococcus Aureus blood stream infections caused by Methicillin Resistant Staphylococcus Aureus are increasing slightly in the community ie;3.9% annually as compared to in 2012-2017.[3] Ghia J C, Waghela S, Rambhad G (2020) conducted a Systemic Literature Review and Meta-Analysis Reporting the Prevalence and Impact of Methicillin Resistant Staphylococcus aureus Infection in India. A total of 34 studies were taken involving 16237 patients. The pooled proportion of Methicillin Resistant Staphylococcus Aureus infection was 26.8%. The infection is seen to be more prominent in male patients i.e, 60.4 % as compared to female patients i.e., 39.6%. The prevalence was higher among adults 18 years and above as compared to paediatric patients. The prevalence of Methicillin Resistant Staphylococcus Aureus in India was relatively high at 27% with a higher proportion observed among men aged >18 years. The high prevalence of Methicillin Resistant Staphylococcus Aureus infections in India requires the implementation of surveillance and preventive measures to combat the spread of Methicillin Resistant Staphylococcus Aureus in both hospital and community settings.[4]

Objectives of the study

- 1. To assess the level of pre-test and post-test knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd year B. Sc Nursing students.
- 2. To assess the effect of Structured Teaching Programme on knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd Year B.Sc. Nursing students.
- To determine the association between pre-test knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection with the selected demographic variables.

MATERIALS AND METHODS

A pre-experimental one-group pre-test post-test design was used for the study to accomplish the objectives. 52nos(Fifty two) 2nd year B.Sc. Nursing students studying in Faculty of Nursing, Assam down town University





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participated in the study from 20th February 2023 to 18th March 2023. Formal consent and permission from the authorities of Assam down town University was taken before the data collection procedure. The tools used in the study was a socio demographic proforma and the Structured knowledge questionnaire(Total no. of items were 20)to collect the information regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection. Descriptive and Inferential statistics were used to analyse the data. The frequency and percentage was calculated to assess the knowledge of the students.

RESULT AND DISCUSSION

The table 1 shows that with regard to age, 28(53.9%) were aged 20 years, 9(17.3%) were aged 21 years, 6(11.5%) were aged 19 and 22 years and 3(5.8%) were aged 23 years. Regarding gender, 43(82.7%) were female and 9(17.3%) were male. Considering the clinical experience, 52(100%) did not have experience. With respect to knowledge, 52(100%) did not have knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection.

Section B

Description of knowledge of students regarding Methicillin Resistant Staphylococcus Aureus Infection

The table 2 depicts that in the pre-test 31(59.62%) had moderately adequate knowledge and 21(40.38%) had inadequate knowledge whereas in the post-test after the Structured Teaching Programme, 46(76.67%) had adequate knowledge and 6(11.54%) had moderately adequate knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection.

Section C

The table 3 shows that the pre-test mean score of knowledge among 2^{nd} year B.Sc. Nursing Students was 11.75 ± 3.10 and the post-test mean score of knowledge was 22.98 ± 2.19 . The mean difference score was 11.23. The calculated paired 't' test value of t = 22.159 was found to be statistically significant at p<0.001 level.

Section D

The table 4 depicts the association of pre-test level of knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd year B.Sc. Nursing students with their selected demographic variables.

- 1. The mean pre test and post test knowledge scores of respondents was 11.75 and 22.98 respectively.
- 2. Comparison of the mean pre test and post test knowledge scores the 't' value 22.15 significant at 0.05 level which indicate that there is a significant difference between the knowledge level of the students before and after the implementation of the structured teaching programme.
- 3. There is an association between the pre- test knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection and age of the students.

The present study was designed to assess the knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection. The research design adopted for the study was One Group Pre - test Post - test design. Non probability purposive sampling technique was used to select 52 students for the study. The data collected for the study were analyzed statistically and discussed based on the objectives.

The first objective of the study was to assess the level of pre-test and post-test knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd year B. Sc Nursing students.

The findings of the present study reveal that in pre-test, 31(59.62%) had moderately adequate knowledge and 21(40.38%) had inadequate knowledge whereas in the post-test after the Structured Teaching Programme, 46 (76.67%) had adequate knowledge and 6 (11.54%) had moderately adequate knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) infection. The present study is supported by a study conducted by Kaur K. Kaur A (2020) to assess the effectiveness of structured teaching program on knowledge MRSA among 50 staff nurses at SGRD Hospital, Vallah, Amritsar. Findings showed that in the pre-test 31 (62%) had moderate knowledge, 13





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(26%) had inadequate knowledge. However, in the post-test, 8(16%) had moderate knowledge, 6(12%) had inadequate knowledge and 36 (72%) had adequate knowledge regarding MRSA. Paired 't' test revealed that pre-test mean was 13.60 \pm 4.768 and post-test mean was 22.28 \pm 6.439. the calculated paired 't' value of t=7.856 was found to be statistically significant at p <0.00001. So, the researcher concluded that STP was effective in improving the knowledge among staff nurses regarding MRSA.[8]

The second objective is to assess the effect of Structured Teaching Programme on knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd Year B.Sc. Nursing students.

The pre-test mean score of knowledge among 2^{nd} year B.Sc. Nursing students was 11.75 ± 3.10 and the post-test mean score of knowledge was 22.98 ± 2.19 . The mean difference score was 11.23. The calculated paired 't' test value of t = 22.159 was found to be statistically significant at p<0.00001 level. This clearly infers that administration of Structured Teaching Programme on knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection was found to be effective in increasing the level of knowledge among 2^{nd} year B.Sc. Nursing students. The present study is supported by a study conducted by Khalil SN and Hasan A (2019) on effectiveness of structured teaching program regarding prevention and control of MRSA on 60 nurses knowledge and attitude in Egypt. The result showed improvement in post-test level of knowledge and calculated paired 't' test value to be 12.617 at (p<0.05) which was highly significant. The study concluded that STP was effective in improving the knowledge regarding prevention and control of MRSA.[9]

The third objective of the study was to determine the association between pre-test knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection with the selected demographic variables. The demographic variable age (χ^2 =13.925, p=0.008) has shown statistically significant association with pre-test level of knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd year B.Sc. Nursing students at p<0.01 level and the other demographic variables has not shown statistically significant association with pre-test level of knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd year B.Sc. Nursing students. The present study is supported by a study conducted by Jose A. (2021) to evaluate the effectiveness of structured teaching program on knowledge regarding Methicillin Resistant Staphylococcus Aureus infection among staff nurses in Tumkur. The result showed that there was a significant difference between pre-test and post-test knowledge score as assessed by the paired 't' test value at 21.56 was higher than the tabulated 't' value of 2.00 at p<0.05 level of significance. The present study showed that age, education status, years of experience, attending inservice class and nurse with MRSA infection showed a significant association with pre-test findings. Thus, the study concluded that STP helps to improve the knowledge of staff nurses on MRSA infection.[10]

CONCLUSION

The present study was conducted to assess the effect of Structured Teaching programme on knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd year B.Sc. Nursing students of selected Nursing college of Guwahati, Assam. The findings of the study revealed that the total post-test knowledge score is significantly higher than pre-test as evidenced by t= 22.159 which indicated that STP is effective. It also reveals that there was a significant association between Age and the pre-test knowledge score regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd year B.Sc. Nursing students. Thus, STP must be regularly included as a part of teaching learning for the nursing students that will help them in gaining knowledge which can be correlated in their clinical practice.

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Table 1: Distribution of demographic variables of the students n=52

SL. NO.	Demographic Variables	Frequency (f)	Percentage (%)
	Age in years		
	19 years	6	11.5
	20 years	28	53.9
1.	21 years	9	17.3
1.	22 years	6	11.5
	23 years	3	5.8
	Gender		
2.	Male	9	17.3
۷.	Female	43	82.7
	Experience		
3.	Yes	-	-
э.	No	52	100





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	Knowledge		
4	Yes	-	-
4.	No	52	100

Table 2: Distribution of respondents based on pre-test and post-test knowledge scores regarding Methicillin

Resistant Staphylococcus Aureus (MRSA) Infection

Level of Knowledge		etest	Post Test	
Level of Knowledge	f	%	f	%
Inadequate knowledge (0 – 10)	21	40.38	1	-
Moderately adequate knowledge (11 – 20)	31	59.62	6	11.54
Adequate knowledge (21 – 30)	-	ı	46	76.67

Table 3: Effect of Structured Teaching Programme on knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection (n = 52)

Comparison knowledge score	Mean	SD	Mean difference	't' test value	Df	<i>'p'</i> value	Inference
Pre-test	11.75	3.10	11 00	22 159	51	0.0001	C***
Post-test	22.98	2.19	11.23	22.159	51	0.0001	5

^{***}p<0.001, S – Significant

Table 4: Association between pre-test knowledge with selected demographic variables regarding methicillin resistant staphylococcus aureus (MRSA) infection

SL. NO.	Demographic variables	Inadequate			erately equate	χ² value	df	<i>'p'</i> value	Inference
		f	%	f	%				
1.	Age in years a.19 years 2 3.6 b.20 years 14 26. c.21 years		9.6	4 14 9 1 3	7.7 26.9 17.3 1.9 5.8	χ²=13.925	4	0.008	S**
2.	Gender a. Male b. Female	3 18	5.8 34.6	6 25	11.5 48.1	χ²=0.225	1	0.635	NS
3.	Experience a. Yes b. No	- 21	- 40.4	- 31	- 59.6	-	-	-	-
4.	Knowledge a. Yes b. No	- 21	- 40.4	- 31	- 59.6	-	-	-	-

^{**}p<0.01, S – Significant, NS – Not Significant





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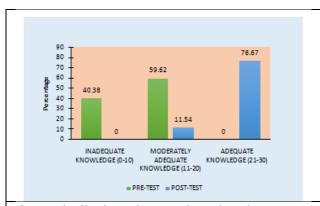


Fig 1: Distribution of respondents based on pre-test and post-test knowledge scores regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection.

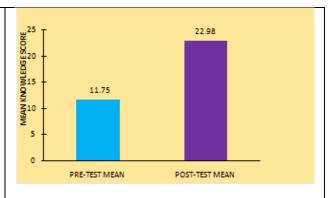


Fig 2: Bar diagram showing the Effect of Structured Teaching Programme on knowledge regarding Methicillin Resistant Staphylococcus Aureus (MRSA) Infection among 2nd year B. Sc Nursing students





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RESEARCH ARTICLE

Fake News Detection using Machine Learning

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ABSTRACT

Fake news is becoming increasingly prevalent on social media and other platforms, which is a serious worry since it has the potential to have devastating effects on society and the country. Its detection is already the subject of extensive research. Using tools like Python's scikit-learn and Natural Language Processing (NLP) for textual analysis, this paper analyzes existing research on fake news detection and investigates the best traditional machine learning models to develop a model of a product with a supervised machine learning algorithm that can classify fake news as true or false. This procedure will provide vectorization and feature extraction; we suggest performing tokenization and feature extraction with the Python scikit-learn module.

Keywords: Fake News Detection, Machine Learning, Text Classification, Natural Language Processing (NLP), Supervised and Unsupervised Learning.

INTRODUCTION

Fake News holds deceptive news that may be checked. This upholds lies about the detail of action in a country or overstated cost of certain duties for a country, which may cause disturbance for a few nations like in Arabic spring. There are arrangements, like the delegation of representatives of Commons and the Crosscheck project, difficult to deal with issues as validating authors are obliged. However, their purview is so restricted because they believe the human manual discovery, in a globe accompanying heaps of items either distant or being written all minute, cannot be accountable or doable manually. A resolution may be, for one incident of a scheme to supply a credible electronic index cut, or grade for the believeableness of various publishers, and information circumstances.





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This paper proposes a method to conceive a model that will discover if an item is real or fake established allure words, phrases, beginnings, and titles, by asking directed machine intelligence algorithms on a defined (branded) dataset that is manually top-secret and guaranteed. Then, feature choice patterns are used to experiment and select high-quality fit faces to acquire the highest accuracy, under disorientation model results. We intend to conceive the model utilizing different categorization algorithms. The fruit model will test the hidden dossier, the results will be drawn, and respectively, the product will be a model that detects and categorizes fake items and maybe secondhand and joined accompanying some system for future use.

RELATED WORK

Social Media and Fake News

Social news contains websites and programs that are committed to forums, public websites, microblogging, friendly bookmarking, and wikis [1][2]. On the other side, few investigators feel the fake revelation is a result of accidental issues to a degree of instructional shock or unsuspecting conduct like what took place in the Nepal Earthquake case [3][4]. In 2020, skilled was extensive fake information having to do with well-being that had unprotected all-encompassing strength in danger. The WHO freed a warning all along early February 2020 that the COVID-19 plague has caused a large 'infodemic', or a spurt of honest and fake revelation— that contained innumerable misstatements.

Natural Language Processing

The main reason for handling a Natural Language Processing search is to examine individual or more specializations of a whole or an invention. The Natural Language Processing (NLP) grade concerning mathematics order authorizes the combination of talk understanding and talk production. In addition, may be exploited to discover conduct accompanying miscellaneous words.[6] submitted a new ideal scheme for distillation conduct from accents of English, Italian, and Dutch talks through applying various pipelines of miscellaneous words to a degree Emotion Analyzer and Detection, Named Entity Recognition (NER), Parts of Speech (POS) Taggers, Chunking, and Semantic Role Labeling fashioned NLP good Subject of the search [5][6]. The Sentiment reasoning [7] extracts empathy on the subject. A sentiment study is collected of gleaning a particular term for a subject, eliciting the belief, and making accompanying relation reasoning. The Sentiment analysis uses two-fold styles Resources for reasoning: Glossary of aim and Sentiment models table. For helpful and Destructive disputes and attempts to present classifications on a level of -5 to 5. Parts of talk taggers forms for accents to a degree in European vocabularies are being investigated to produce parts of prose taggers forms in different languages to a degree Sanskrit [8], Hindi [9], and Arabic. Can be adept in Mark and classification conversation as names, words that modify nouns, gerunds, thus. Most indiscriminate talk methods may act efficiently in European dialects, but not in Asian or Arabic expressions. Part of the Sanskrit discussion "talk" specifically uses the forest-bank form. The Arabic takes advantage of Vector Machine (SVM) [10] and uses order to as a matter of usual practice recognize letters and parts of talk and without thinking reveal elementary sentences in the Arabic manual [11].

Data Mining

Data excavating methods are classified into two main procedures, that is; supervised and alone. The directed order exploits the preparation facts so that predict the secret exercises. Unsupervised Data Mining is a try to see secret dossier models given outside providing preparation dossier, for instance, pairs of input labels and classifications. A model instance for alone dossier excavating is aggregate mines and a mob base [12].

Machine Learning (ML) Classification

Machine Learning (ML) is a class of algorithms that help program methods gain more correct results outside bearing to reprogram bureaucracy straightforwardly. Data physicists typify changes or traits that the model needs to analyze and take advantage of to cultivate forecasts. When the preparation is achieved, the invention splits the





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well-informed levels into a new dossier [11]. Six algorithms are selected in this place paper for classifying the fake information.

Decision Tree

The resolution shrub is a main finish that everything established flow chart like makeup that is to say principally secondhand for categorization questions. Each within bud of the conclusion shrub designates a condition or a "test" on attribute and the separate is approved on the base of the test environments and result. Finally, the leaf bud bears a class label that is to say obtained later calculating all attributes. The distance from the root to the leaf shows the categorization rule. The wonderful year is that it can work together type and contingent changeable. They are good at recognizing the ultimate main variables and they likewise describe the connection betwixt the variables quite suitably. They are important in creating new variables and faces that are useful for dossier surveys and predict the mark changing quite capably.

Decision Tree Pseudo-code

Generate Decision Tree(Sample s, features F)

- 1. If stop $_$ conditions(S,F) = true then
 - a. leaf = create_Node()
 - b. Leaf.lable=classify(s)
 - c. Return leaf
- root = create_Node()
- 3. root.testcondition = find_bestSplit(s,f)
- 4. $v = \{ v \mid v \text{ a possible outcome of root.testconditions} \}$
- 5. for each value v⊚ V:
- 6. $sv: = \{s \otimes root.testcondition(s) \neq v \text{ and } s \otimes S\};$
- 7. child = Tree_Growth(Sv,F);
- 8. Grow child as a descent of roof and label the edge (root→child) as
- 9. Return root

Tree-located knowledge algorithms are widely with predicting models utilizing directed learning orders to demonstrate extreme accuracy. They are good at planning non-uninterrupted connections. They answer the classification or reversion questions completely well and are also referred to as CART [13][14][15].

Random Forest

Random Forest are erected on the idea of building many resolution shrub algorithms, afterwards which the resolution wood takes a separate result. The results that are envisioned by a lot of decision wood, are distracted apiece random woodland. To guarantee a difference between the conclusion trees, the chance wood carelessly selects a subcategory of properties for each group [16][17]The relevance of Random woodland is best when used on uncorrelated conclusion shrubs. If used on similar seedlings, the overall result will be approximately related to a single-resolution forest. Uncorrelated conclusion trees may be acquired by bootstrapping and feature unpredictability.

Random Forest Pseudo-code

To make n classifiers

For i = 1 to n do

Sample the training data T randomly with replacement for Ti output Build a Ticontaining root node, Ni

Call Build Tree (Ni) end For

Build Tree (N):

If N includes instances of only one class, then returns else





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Select z% of the possible splitting characteristics at random in N Select the feature F with the highest information gain to split on Create f child nodes of N, Ni ,..., Nf , where F has f possible values (F1, ... , Ff) For i = 1 to f do Set the contents of Ni to Ti, where Ti is all instances in N that match Fi Call Buildtree (Ni) end for end if [18]

Support Vector Machine (SVM)

The SVM treasure establishes the geography of each dossier part in the form of a point in a range of ranges n (the number of free features), and the profit of a likely characteristic is the number of particularized relates [13]. Given a set of n countenance, SVM invention uses n spatial scope to plot the dossier part accompanying the relates delineating the advantage of each feature. The energetic plane acquired to separate two together classes is secondhand for classifying the dossier.

SVM Pseudo-Code

```
F[0..N-1]: a feature set with N features that is sorted by information gain in decreasing order accuracy(i):

accuracy of a prediction model based on SVM with F[0...i] gone set low = 0

high = N-1

value = accuracy(N-1) IG_RFE_SVM(F[0...N-1], value,
low, high) {

If (high } > low)

Return F[0...N-1] and value mid =

(low + high ) / 2 value_2 =

accuracy(mid)

if (value_2 < value)

return IG_RFE_SVM(F[0...mid], value_2, low, mid)

else (value_2 > value)

return IG_REF_SVM(F[0...high], value, mid, high) [13]
```

Naive Bayes

This invention everything on Baye's hypothesis under the provided that allure empty predictors and is secondhand in diversified machine learning questions [18]. Simply set, Naive Bayes adopts one function in the classification that has no commotion accompanying another. For example, the product will be top-secret as a sphere when the allure of rose color, swirls, and width is nearly 3 inches. Regardless of whether these functions depend on each one or various functions, and even though these functions believe each one or on additional functions, Naive Bayes adopts that all these functions share additional evidence of the sphere [14]

```
P(c|x) = P(x|c)P(c)

P(c|x)=P(x|c)x P(x|c)x...xP(x2q|c)xP(c)

P(c \setminus X) is the posterior Probability

P(x) is the Likelihood.

P(c) is the Class Prior Probability. P(x) is the Predictor Prior Probability.
```

Naive Bayes Pseudo-code

```
Training dataset T,
F= (f1, f2, f3,..., fn) // value of the predictor variable in testing dataset.
Output:
A class of testing datasets.
Step:
```





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- 1. Read Training Dataset T;
- 2. Calculate the mean and norm of each class's predictor variables;
- 3. Repeat
- 4. Calculating the likelihood of using the equation of gauss density in each class;
- 5. Until Pending the estimation of the likelihood of all predictor variables (f1, f2, f3,..., fn),.
- 6. Calculated the likelihood for the respective class;
- 7. Get the highest likelihood;
- 8. (Researchgate.net, 2018)

Random Forest (RF) and Naïve Bayes have many differences, the main one is their model size. The NB models are not good at representing complex behavior, resulting in low model size, and good for a constant type of data. In contrast, the model size for the Random Forest model is very large and it might result in overfitting. NB is good for dynamic data and can be reshaped easily when new data is inserted while using an RF may require a rebuild of the forest every time a change is introduced.

KNN (k- Nearest Neighbors)

KNN classifies new positions based on most of the sounds from the neighboring k concerning them. The position assigned in the class is highly mutually exclusive between the nearest neighbors K, as measured by the role of the distance [15].

KNN Pseudo-code

Classify $(\mathbf{X}, \mathbf{Y}, x)$ // \mathbf{X} : training data, \mathbf{Y} : class labels of \mathbf{X} , x: unidentified sample For i = 1 to do Calculate distance d $(\mathbf{X}i, x)$ end for

Calculate set *I* containing indices for *k* smallest distances d(Xi, x).

return majority label for $\{Yi \text{ where } i \mid I\}[16]$

KNN falls in the type of directed learning and allure's main uses are interruption discovery and pattern recognition. It is nonparametric, so no particular dispersion is filling a place in the dossier or any power is created about the ruling class. For example, GMM adopts a Gaussian distribution of the likely dossier.

Combining Classifiers

Achieving high-quality likely taxonomic acting is the primary aim when preparation paradigm detecting wholes. For that reason, various classification planners for the models of detecting conduct are capable of expected advancement. Variant classification planners can present additional facts for the models. With these supplementary facts, the killing of individual models can be upgraded 19].

Related Work on Fake News Detection

Identified miscellaneous beginnings of television and made the acceptable studies either the complied item is reliable or fake. [20] The paper applies models' established talk traits and predicts models that do not fit accompanying the added current models. Secondhand naïve Bayes classifier to discover fake news by Naïve Bayes. This design acted as an operating system foundation and tested it with miscellaneous records from Facebook, etc., happening in a veracity of 74%. The paper ignored the punctuation mistakes, developing weak veracity. Estimated miscellaneous ML algorithms and fashioned the research on the portion of the indicator. The veracity of various predicting patterns contained confined resolution trees, slope augmentation, and support heading tools were various. The patterns are estimated to establish a fickle expectation beginning with 85-91% veracity. Exploited the Naïve Bayes classifier, examine in what way or manner to implement fake revelation discovery to various public television sites. They secondhand Facebook, Twitter, and additional public wireless requests as a file origin for revelation. Accuracy is very lowered cause the revelation on this setting is not 100% believable. [24][25][26] Review puzzling and revealing rumors in actual time for action or event for operation or event. It engages a gadget-situated characteristic and derives allure file origin from Kaggle. The veracity average having to do with this pattern is 74.5%. Clickbait and origins do turn down sly, occurrences in a lower determination. [27] Used to label Twitter shopping mail senders.





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Among the various models used are the trusting Bayes algorithms, the assembling, and the judgment plant. The true average of detecting spammers is 70% and fraudsters are 71.2%. The models used have worked out a concave level of in-text veracity to separate spammers from non-unsolicited calls. Projected to impose upon vehicle perception plans to uncover fake revelation. Three average plans are employed through their research: Naïve Bayes, Neural Network, and Support Vector Machine (SVM). Normalization system is an essential stage in dossier washing former gadget brilliance is used to classification the file. The amount rooted that Naïve Bayes has a truth of 96.08% for detecting fake plans. Two more superior designs, the pertain order and the hierarchy title (SVM) accomplished a veracity of 99.90%. In [30] it has been raised that fake telling discovery is an anticipating interpretation request. Detecting counterfeit plans includes the three stages of the handle, feature inception, and classification. The composite classification model in this research is conceived as exhibition fake telling. The blend of categorization is a union of KNN and random forest. The murder of the offered model is resolved for truth and recall. The final results were reinforced by just before 8% utilizing various lying plan finding models. [31][32] Inspected by what fake facts were used in the 2012 Dutch elections on Twitter. She checks the murder of 8 supervised automobile judgment classifiers in the Twitter dataset [33]. We achieved that the judgment plant invention entirety best for the fundamental document file used following an F score of 88%. 613,033 tweets were ordered, of which 328,897 were deliberately truthful and 284,136 were lying. By ironing out the concerning qualities, not quantities content of fake tweets consigned concurrently with an activity the selection, face, and features of the wrong content were authenticated and removed into six differing types [34]. [29] Bestowed a counterfeit discovery model promoting N-grandam study of each glass of distinctive characteristic distillate plans. In addition, we examined the ancestry orders of varying lineaments and six miscellaneous plans of machine intelligence. The throwed model achieves the highest rank truth prevalent Contains a unigram and an uninterrupted SVM textbook. The best truth is 92%. Methodology this separation presents the systems used for the categorization. Using this model, a form is performed for detecting the fake items.

In this order directed gadget acumen is used for classifying the dataset. The origin of this place-place categorization question is dataset group point, accompanied by preprocessing, executing face draft, then acting the preparation and experiment of the dataset and forever running the classifiers [35][36][37][38][39]. Figure [1] details the projected structure methodology. The method is established by transporting miscellaneous experiments on the dataset using the algorithms interpreted in the premature division chosen Random forest, SVM and Naïve Bayes, plurality polling, and added classifiers. The experiments are attended individually on each treasure, and in alliance with the ruling class for best accuracy and accuracy [40][41][42]. The main aim search to request a set of categorization algorithms to acquire a categorization model that be secondhand as a scanning of documents for a fake revelation by analyses of information discovery and implant the model in Python request expected secondhand as a finding for the fake revelation dossier [43][44]. Also, appropriate refactoring has happened acted on the Python rule to produce a revamped rule [25][26]. The categorization algorithms used in this place model are k-nearest Neighbors (k-NN), Linear Regression, XGBoost, Naive Bayes, Decision Tree, Random Forests, and Support Vector Machine (SVM). All these algorithms are as correct as attainable. Where trustworthy from the merger of the average of bureaucracy and equate bureaucracy. As proved in figure [2], the dataset is used for various algorithms so discover a fake revelation. The veracity of the results got is resolved in the end the things are produced. In the process of model concoction, the approach to detecting governmental fake information is in this manner:

The first step is group the governmental revelation dataset, (the Liar dataset is selected for the model), perform preprocessing through harsh blast expulsion, the next step search out administer the NLTK (Natural Language Toolkit) to act POS and visage are picked. Next act the dataset dividing ask ML algorithms (Naïve bays and Random woodland) before constituting the proposed classifier model. Fig 2 shows that subsequently the NLTK is used, and the Dataset gets favorably preprocessed in bureaucracy before meaning is produced for administering algorithms on the prepared portion. The system reaction accompanying N.B. and Random wood is used before the model is created accompanying the reaction idea. Testing is acted on the test dataset, and the results are confirmed, the next step search out and monitor the accuracy for agreement. The model is therefore used on a hidden dossier picked by the consumer. The full dataset is created accompanying half of the dossier being fake and half accompanying absolute items, so making the model's do over veracity 50%. A random excerpt of 80% dossier is finished from the fake and





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actual dataset expected secondhand in our complete dataset and leave the remaining 20% to be secondhand as an experiment set when our model is complete. Text dossier demands preprocessing before administering classifier on it, so we will clean buzz, utilizing Stanford NLP (Natural language processing) for POS (Part of Speech) transformation and tokenization of dispute, therefore we must encrypt the developed dossier as integers and buoyant point values expected authorized as a recommendation to ML algorithms. This process will influence feature distillation and vectorization; the research utilizing Python scikit- discover book repository to act tokenization and feature origin of theme dossier, cause this athenaeum contains beneficial finishes like Count Vectorizer and Tiff Vectorizer. Data is regarded in graphical performance accompanying disorientation mold. Refer to figure 3. This portion examines the preferred dataset, The LIAR-PLUS Master which has happened secondhand for cleansing and gleaning the basic document file, and the algorithms are used. This dataset has extracted authentication sentences from the brimming-idea decree item written in Politifact by broadcasters. As proved in the following figure 4 we secondhand the lineaments of Truth principles, also used a few talks on the assertion to receive another 4 facial Characteristics (nouns, verbs, prepositions, and sentences), and each record is described by class label as (0, 1, 2, 3) expected secondhand in preparation the model. The following steps have been used to judge the accuracy of the information.

- 1. Liar-dataset is preprocessed 12.8K
- 2. The texts in diversified circumstances are captured from POLITIFACT.COM and are marked manually. Then it is revolutionized from the TSV plan into a CSV plan utilizing Python.
- 3. The next step search out and clean the buzz using NLP NLTK athenaeums and SAFAR v2 study. The buzz includes IDs, dots, commas, citations, and by preventing conditions, remove the affix. The next step search to use POS (Part of the talk) that will turn the dataset into tokens and mathematical principles.
- 4. Perform feature ancestry by selecting semantic visages, Such as word count, average discussion time, time of item, number count, and number of portions of talk (qualifier).
- 5. Extract unigram and bigram facial characteristics by utilizing the Tfidf Vectorizer function of Python sklearn. Feature origin book repository to create TF-IDF n-grandam appearance.
- 6. Divide the dataset into 70% for training and 30% for testing utilizing Python sklearn.
- 7. Produce categorization model ipynb file subsequently requesting all the algorithms.
- 8. Test model accuracy on the test portion of the dataset and produce confusion cast.
- 9. Evaluate veracity, accuracy, recall, and f1-score for fake and palpable revelation.
- 10. Design the connection expected secondhand for experiment hidden information by consumer.

The dossier is detached it into two parts: The first division, that resides of 75% of the dossier, is a prepared dossier, place the treasure detects the absolute revelation and dishonest revelation ,therefore the dossier is described in the form of 0 and 1 place 0 is for wrong information and 1 for valid information. After that, the rest of the dossier, that is 25% of it, will do a test on it, because it understand either the revelation is type or fake, and therefore return it as long as it was right or wrong, and in accordance with the allotment legitimate and wrong, the invention portion will be made. Refer figure 5 and 6.

RESULTS

The outlook concerning this project search covers the governmental information dossier, of a dataset famous as the Liar-dataset, it is a New Benchmark Dataset for Fake News Detection and described by fake or trust information. We have acted study on the "Liar" dataset. The results of the study of the datasets utilizing the six algorithms have described utilizing the disorientation cast. The six algorithms secondhand for the discovery are as:

- XGboost.
- · Random Forests.
- Naive Bayes.
- K-Nearest Neighbors (KNN).
- Decision Tree.





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SVM

The disorientation cast is inevitably acquired by the Python rule utilizing the intelligent knowledge athenaeum when running the invention rule in the Anaconda principle. The Confusion Matrix for all the algorithms are depicted below in figure 7: Figure 8 expresses the accuracies of these algorithms. As shown the XGBOOST is depicting the highest accuracy with more than 75%, next is SVM and Random forest with approximately 73% accuracy.

CONCLUSION

The research in this place paper focuses on detecting fake information by inspecting it in two stages: characterization and announcement. In the exploratory, the elementary ideas and laws of fake information are highlighted in public news. During the finding stage, the current designs are inspected for the discovery of fake news utilizing various directed education algorithms. As for [20] the presented fake news discovery approaches that is to say established content reasoning in the paper employ models based on talk traits and predicting models that do inappropriately accompany the additional current models. From [21] they utilized the Naive Bayes classifier to discover fake revelation from various beginnings, accompanying results of veracity of 74%. [22] Used combined ML algorithms, but they believe fickle expectation beginning accompanying 85-91% accuracy. [23] Uses the Naive Bayes to discover fake information from various friendly publishing websites, but the results were not correct for the untruthful beginnings. [24] They took their dossier from Kaggle accompanying average veracity of 74.5%. [27] Used Naive Bayes algorithms to discover Twitter spam senders, accompanying veracity ranked from 70% to 71.2%. [28] They are reliable in various approaches with a veracity of 76%. [29] Three accepted patterns are promoted through their research: Naïve Bayes, Neural Network, and Support Vector Machine (SVM). Naïve Bayes has a veracity of 96.08% for detecting fake ideas. The neural network and the automobile heading (SVM) attained a veracity of 99.9 0%. [30] The second hand the association of KNN and random jungles that present the conclusive results upgraded by 8% utilizing a mixed fake communication discovery model. [31] They processed on 2012 Dutch elections revelation on Twitter, they examined the killing of 8 directed machine intelligence classifiers in the Twitter dataset.

They acquire that the conclusion wood algorithm everything best for the basic document file secondhand accompanying an F score of 88%. [32] Presented a counterfeit discovery model utilizing N-gram reasoning attained the maximal veracity common contains a unigram and an undeviating SVM text. The chief veracity is 92%. In the earlier research summary and order analysis, we decided that most of the research documents secondhand naïve bays treasure, and the forecast accuracy was between 70-76%, they mainly use approximate study contingent upon belief analysis, titles, discussion commonness duplication [40][41][42]. In our approach we suggest increasing these methods, another aspect is POS textual reasoning, which is an all-inclusive approach, it depends on increasing mathematical values as visage, we think that growing these lineaments and utilizing chance forest will present further bettering to highest in rank results. The physiognomy we intend to add to our dataset is total dispute (tokens), Total singular dispute (types), Type/Token Ratio (TTR), Number of sentences, Average sentence distance (ASL), Number of types, Average discussion length (AWL), nouns, prepositions, adnouns, etc.

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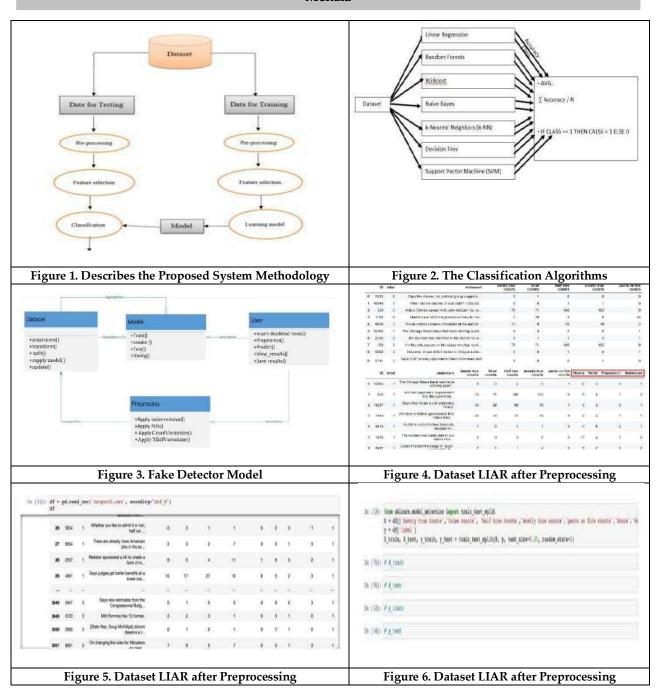




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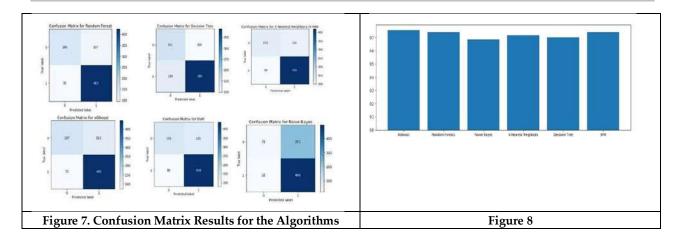
















RESEARCH ARTICLE

Medical Images De-Noising Using Different Filtering Techniques and Their Performance Analysis

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ABSTRACT

In the last twenty years, medical imaging and diagnostic procedures have become increasingly popular due to significant progress in computer, internet, data storage, and wireless technologies. The effect of these breakthroughs is apparent in the sphere of medicine and medical sciences, facilitating the detection and treatment of numerous ailments more effectively. Moreover, medical imaging is commonly warranted for the purpose of monitoring a previously analysed and treated condition. Medical images, like other imaging modalities, are prone to noise and art e facts. The noise can either be random or white noise, which has a uniform frequency distribution. Alternatively, the noise could also be frequencydependent, either from the device's mechanism or signal processing techniques. The presence of noise in images can cause them to be indistinct, which can complicate the diagnosis and analysis of diseases. This, in turn, can lead to significant losses, even fatalities. Therefore, the denoising of medical images is a necessary and crucial pre-processing approach for subsequent stages of medical image processing. This work introduces the incorporation of diverse types of noise into a range of medical images, including Mammogram, CT Scan Image, X-Ray Images, Brain MRI images, and Retina Images. Next, we applied various filtering techniques to decrease or eliminate noise from the photos and conducted a performance analysis of the denoised images.

Keywords: medical imaging; noise; de-noising; filtering.





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INTRODUCTION

Images are inevitably affected by noise during the processes of acquisition, compression, and transmission due to several factors such as the environment and transmission channel. This auditory disturbance leads to modification and deprivation of visual data. Noise has a detrimental effect on subsequent image processing tasks, such as video processing, picture analysis, and tracking. Therefore, the technique of minimizing noise in images is highly important in modern image processing systems. Image denoising is the process of removing noise from a noisy image to recover the original image. However, the denoising procedure becomes tough because of the frequent occurrence of noise, edge, and texture, making it difficult to distinguish them and leading to the unavoidable loss of certain information in the denoised photos. The task of acquiring superior photographs by eliminating noise and obtaining pertinent data has become a prominent obstacle. Medical imaging and diagnostic tools have undergone significant advancements in recent decades and have become an essential component of disease diagnosis. Medical images play a crucial role in providing information about the heart, brain, nerves, and other interior structures of the human body. Medical images can be analysed using various mathematical techniques to determine if healthy tissue has been affected by infection. Nevertheless, the loss of a specific region during medical imaging might potentially lead to catastrophic outcomes, including mortality. The primary obstacle in the medical imaging process is to acquire a picture without any substantial loss of information. The likelihood of the images being corrupted by noise or artefacts during the capture and/or subsequent processing phases is very high. Noise can be defined as the stochastic alteration of the initial pixel value. Image quality is diminished by noise, which is particularly pronounced when capturing small objects with relatively low contrast. Medical photos exhibit lower contrast in comparison to regular images. It is highly important to remove the noise included in medical images as they can significantly reduce image quality and hinder disease detection. Hence, the elimination of noise from medical images is crucial and has evolved into a vital preliminary process in medical imaging systems. The often employed medical imaging modalities are Ultrasound (US) photographs, Magnetic Resonance (MR) photos, Computed Tomography (CT) images, Retina Image, and X Ray photographs etc.

NOISE MODEL

The relationship between the observed noisy image (Y), the unknown clean image (X), and the additive noise (N) can be represented as follows:

$$Y = X + N$$

The goal of noise reduction is to decrease the presence of noise in unedited pictures while minimizing the deterioration of original characteristics and improving the signal-to-noise ratio (SNR). The main challenges for image de-noising are as follows:

- Flat surfaces should exhibit a high level of smoothness.
- The edges should be safeguarded from becoming blurred.
- Textures should be maintained in their original form.
- The process should not introduce any new artefacts.

Different types of noise in medical imaging Gaussian Noise

Gaussian noise, commonly referred to as white noise, is a form of statistical noise characterized by a probability density function (PDF) that conforms to a normal distribution, or Gaussian distribution. Gaussian noise is the occurrence of random fluctuations in pixel values that conform to a Gaussian distribution. Such noise might arise from variables like sensor constraints, transmission inaccuracies, or environmental interferences. Gaussian noise can cause a digital image to have a minor graininess or speckling effect, leading to a decrease in the overall image quality. It can impact image processing activities including edge identification, image enhancement, and picture compression,





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resulting in inaccuracies and artifacts. The Gaussian random variable z is characterized by its probability density function (PDF) p, which is defined as:

$$arphi(z) = rac{1}{\sigma\sqrt{2\pi}}e^{-(z-\mu)^2/(2\sigma^2)}$$

where z is representing the grey level, μ is the mean grey value and σ its standard deviation. Salt and pepper noise: Salt-and-pepper noise, commonly referred to as impulse noise, is a form of noise that can manifest in digital photographs. The issue manifests as sporadic, solitary, and infrequent dark and white pixels that can diminish the image's clarity. The term is derived from the resemblance of salt and pepper being sprinkled on the image.

$$P(z) = \begin{cases} Px & for \ z = x \\ Py & for \ z = y \\ 0 & Otherwise \end{cases}$$

When an image is transformed from one location to another, salt and pepper noise can annoy the viewer. The result was an image that was more likely to appear disrupted. There are just two possible values for **a** and**b**for a salt and pepper model, and the likelihood of finding either one is less than 0.1. Typically, pepper noise has an intensity value close to 0 for 8-bit pixel images, while salt noise has an intensity value of 255.

$$PDF(salt\&pepper) = \begin{cases} A & for \ g = a("pepper") \\ B & for \ g = b("salt") \end{cases}$$

A widely used technique for eliminating salt and pepper noise in an image is to employ a median filter. This filter substitutes the value of each pixel with the median value of the intensities in the neighbourhood of that pixel. This method effectively eliminates the isolated salt and pepper noise while minimizing image blurring.

Quantization noise

Quantization noise in digital images occurs due to the process of converting continuous-tone analog signals (such as those captured by a camera sensor) into discrete digital values. When an analog image is digitized, variations in color and intensity are represented by discrete numerical values. Quantization noise in digital images arises from the difference between the original continuous-tone image and the digitized representation. In the context of digital images, quantization noise can manifest as visible artifacts, especially in areas with smooth gradients or subtle variations in color and brightness. To mitigate quantization noise in digital images, various techniques can be utilized. For example, increasing the bit depth of the image can reduce the impact of quantization noise by allowing for a greater range of discrete levels to represent color and intensity values. Understanding and managing quantization noise is a crucial aspect of digital image processing, particularly in fields such as photography, medical imaging, and computer graphics, where image quality is of paramount importance. Image histograms are useful for identifying significant quantization mistakes that occur due to a decrease in bit resolution.

Poisson Noise

Unsystematic fluctuations of photons are the source of this noise. Because of the photons' impact as they enter one sensor after another, researchers frequently refer to Poisson noise as photo shoot noise.

Speckle Noise

Because it is possible to represent speckle noise by multiplying random values by pixel values, this type of noise is also known as multiplicative noise. In certain radar applications, it creates significant issues. You may find its probability function by plugging in the values of gamma radiation into the following equation.

$$F(g) = \frac{g^{\alpha-1} e^{\frac{-g}{a}}}{\alpha - 1! a^{\alpha}}$$





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FILTERING TECNIQUES

Median Filter

Minimize noise while preserving edges and intricate details by employing a median filter, a nonlinear technique extensively utilized in the field of signal and image processing. It works by taking the median of the intensities close to each pixel and using it as a replacement for the pixel's original intensity value. When it comes to eliminating impulsive noise, like salt-and-pepper noise, the median filter really shines. Because it causes isolated dark and bright patches due to abrupt and haphazard sharp changes in pixel values, this noise frequently degrades picture quality. When compared to linear filters, the median filter is better at reducing noise without introducing blurring into the picture. The pixel intensities in the surrounding area are compared using a predetermined window size, and the median value is used to set the new intensity for the central pixel. While maintaining the image's general structure and edges, this method efficiently eliminates outliers.

Gaussian Blur Filter

When processing images, a Gaussian blur filter is a common linear filter for reducing noise and detail while keeping edges intact. The input image is passed through a convolution process with a Gaussian kernel to make it work. The values of the Gaussian kernel matrix are determined by the Gaussian function, which, depending on the distance from the centre, assigns a higher weight to the central pixel and a lower weight to the surrounding pixels. By applying a smoothing effect, the Gaussian filter effectively reduces noise and eliminates small details in the image. Image de-noising and other pre-processing activities like feature extraction and pattern identification benefit greatly from this. The standard deviation (σ) of the Gaussian function determines the degree of blurring that a Gaussian filter achieves. If the standard deviation is large, the blur effect is significant; if it is little, the blur impact is mild.

$$GC[I]_{\mathbf{p}} = \sum_{\mathbf{q} \in S} G_{\sigma}(\|\mathbf{p} - \mathbf{q}\|) I_{\mathbf{q}},$$

Gaussian filtering involves calculating a weighted average of the intensity values of neighbouring points, where the weight assigned to each position decreases as the spatial distance from the central position p increases. The weight assigned to pixel q is determined by the Gaussian function

 $G\sigma(||p-q||)$

where σ is a parameter that specifies the size of the neighbourhood.

The Non-Local Means (NLM) Filter: The Non-Local Means (NLM) filter is a widely used denoising technique in image processing. Unlike traditional local filtering methods, the NLM filter leverages similarities across the entire image to effectively reduce noise while preserving image details and textures. The key principle behind the NLM filter is to substitute the intensity of a pixel with a weighted average of all the pixels in the image, rather than just the neighbouring pixels as in local filtering methods. The weight assigned to each pixel is determined by evaluating the similarity between patches cantered at the current pixel and probable matching patches throughout the entire image. This method enables the NLM filter to preserve intricate visual details while efficiently suppressing noise. The NLM filter's capacity to use non-local similarities throughout the image renders it highly efficient in diminishing various forms of noise, such as Gaussian noise and salt-and-pepper noise, while preserving edges and texture details with minimal blurring. Additionally, it is regarded as effective in reducing noise in both grey scale and colour photographs.

Bilateral Filter

Bilateral filtering is a non-linear edge-preserving smoothing filter used in image processing and computer vision. It aims to reduce noise while preserving the edges and fine details of an image. Unlike linear filters, which apply a weighted average of neighbouring pixel values, bilateral filtering takes into account both the spatial distance and intensity differences when calculating the weighted average. The bilateral filter defines the weight of each neighbouring pixel based on two factors: the spatial distance between the centre pixel and the neighbouring pixel, and the intensity difference between the centre pixel and the neighbouring pixel. By incorporating both spatial and intensity information, the filter effectively smooths the image while preserving edges and fine details. One of the key





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advantages of bilateral filtering is its ability to reduce noise without significantly blurring edges, making it particularly useful for applications where preserving sharp transitions and fine details is essential. The bilateral filter, denoted asBF[·], is formally defined by:

$$BF(I)P = 1/\text{Wp}\sum_{q \in S} \text{Gos}(||p - q||) \text{Gor}(|Ip - Iq|) \text{Iq}$$

The normalization factor Wp guarantees that the weights of the pixels add up to 1.0.

The Significant contribution of this research study as follows:

- Adding various types of noise like Impulse noise (Salt & Pepper), Gaussian Noise and Quantization Noise, externally to different medical images like XRAY, CT Scan, Retina, Brain MRI, Mammogram images.
- Applying different filtering techniques like Nonlocal means filter, Median Filter, Gaussian Blur Filter and Bilateral filter on those distorted images to achieve noise free images.
- Quantitative performance analysis on those images. How different filter works on

Remaining portions of this paper is outlined as Literature review. Next, the authors have laid out the steps for implementing the suggested system. The last section presents the results analysed, discusses them, and then offers a conclusion.

LITERATURE REVIEW

In their discussion of the different forms of noise in mammography images, R. Gondal& et al., 2021 [1] demonstrated a number of techniques for denoising such images. In 2018, A. Nayak and A. Verma worked on [2]. The authors conduct a thorough investigation into various forms of noise, testing out several strategies and evaluating how well they deal with image de-noising problems. But in 2017 [3], S. Sumanth and A. Suresh outlined various mechanisms regarding noise model kinds and how they impact digital images during transmission. Additionally, discuss the many picture filter methods used for de-noising images and process to choose the best filtering based on the noise's behaviour. The work of J. Nader and colleagues in 2017 [4]. Analytical observation yields several techniques to lessen specified noise, and their article exhibits salt and pepper with affects of Gaussian noise. R. Rowaida and S. Tania (2016) [5]. In order to improve the damaged photos, you should conduct new empirical studies and comparative research on various models and compare their performance. G. Kaur and colleagues (2016) [6]. Using their masks to detect and eliminate noise, they brought up a number of noise-related methods. The outcomes varied across filters, and some of them even reduced image quality or eliminated edges. P. Athira and colleagues (2016) [7]. Their study primarily discusses the picture's use in biomedical research, with a particular emphasis on the de-noising of certain mammography image noises. M. Pious and colleagues (2015)[8]. Presented many noise instances that impact image quality and then demonstrated various approaches of effective de-noising.

A few combined noise reduction strategies are also described, since the noise does not always exist individually and may even attack the photos with multiple types of noise. N. Tiwari and A. Ojha, 2015[9]. Overseen a number of different types of noise that cause picture corruption; concurrently, they demonstrate over five different methods for restoring the original image. Kaur, S., 2015 [10]. She divided her article into sections that addressed the shape and form of the noise and its creeping onto the photos. I have incorporated a plethora of algorithms for picture filtering. In order to compare the performance of each filter type, the research report presents many parameters in its concluding parts. Article referenced as "11" is A. Vijayalakshmi and colleagues from 2014. They Provide an example of a comprehensive study on de-noising models and their effectiveness, including a quick comparison. The authors also cited [12] (B. Kaur & M. Shukla, 2014). The image contains noise in many forms. The most common kind of noise, or the components that people find annoying, like pulse noise or salt and pepper noise, appears as black and white pixels on photographs. Using a middle channel or contras symphonious middle channel [13,14, 15] is an effective method for reducing this type of noise. The Gaussian distribution, also known as the normal distribution, is an approximation density function that is similar to that of Gaussian noise, another well-known type of noise. The fact





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that the possible values for the noise are distributed in a Gaussian fashion is another way to describe Gaussian noise [16, 17, 18, 19]. According to Kaur et al., a modified adaptive bilateral filter [20] may effectively remove the Gaussian noise. Using a Generative Adhesive Network (GAN), Tripathi and Lipton suggested de-noising and projection-based correction in 2018 [21]. They proposed using Generative Adversarial Networks to de-noise the corrupted photos, and they were successful in doing so. In order to get a high-quality image and get it to work with BM3D, the author denoises the damaged image in two steps: first, by roughly recovering the latent vector. Second, we prove that the latent vectors recovered from noisy images have a bias that is trustworthy. Although he conducted his trials on grayscale images, J.M. et al. [22] presented an alternative noise removal method in 2015. A similar two-stage process was used to modify noise pixels. They began by filtering out mixed-signal noise using a fuzzy approach. This study's noise reduction techniques used a mix of Gaussian and salt & pepper noises.

By striking a good balance between the two competing goals of noise reduction and detail preservation, this approach outperformed a number of fuzzy logics. Afifi et al. [23] proposed a modified Poisson mix method that same year. Compared to previous procedures, MPB (Modified Poisson Blending) produces more natural composite images and moderates bleeding issues, therefore their trial findings were positive. They forego pixel powers in favour of the angle area used in Poisson picture advancement, which has two major drawbacks: color reflection and reflection objects. A method for developing contrast and grey level grouping was suggested by Patel et al. [24]. Their goal was to enhance the ability to compare noise features and faults. Visualizing breast tumors in higher density also aids in the detection of breast cancer, according to this there was an improvement in the breast mammography without a loss of picture artifacts. The procedure is straightforward and efficient in terms of computing power. In addition to avoiding any undesirable qualities that may arise during the traditional process, the method kept the average brightness constant while keeping the image's features [25]. For eliminating the Gaussian noise, Yang et al. [26] suggested an approach that works. In this approach, they suggested a powerful de-noising algorithm that combines Poisson and Gaussian probability distributions. It builds more accurate model which applies the contour-let transform, thatshows the directional components of images sparsely. Among these are the transform-domain hidden Markov models that use frameworks and noise approximations. The results of the experiment prove that the suggested image improved the photographs.

METHODOLOGY

There are three stages to carried out the research work:

- The first step is to add noise to different medical images mentioned previously.
- Step two was showing application of various filters to the images in order to remove noise. The initial step of
 our investigation introduced distortion, which these filters serve to eliminate. These filters are studied
 and discussed in the previous section.
- The third stage involved obtaining the output image. Then, using this information, the tests were conducted successfully, yielding the desired results of obtaining the actual image again after adding and eliminating noises by performance analysis through PSNR.

RESULT AND PERFORMANCE ANALYSIS

The visual assessment of image de-noising is possible. However, it insufficient to determine the efficacy of an algorithm. In order to quantify the outcomes, it is important to assess certain performance measures. The PSNR (Peak Signal-to-Noise Ratio) metric is employed in this research as a quantitative tool for measuring performance. Peak signal to noise ratio (PSNR) is a metric used to measure the quality of a signal by comparing the maximum possible signal power to the noise power. PSNR is the ratio of the greatest power of a signal to the power of noise that affects the signal. The Peak Signal-to-Noise Ratio (PSNR) of a de-noised signal Q, given a noise-free signal P of size $M \times N$, is computed as follows:





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$$PSNR(P, Q) = 10\log_{10}\left(\frac{255^2}{MSE}\right)$$

Where

$$MSE = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} [P_{i,j} - Q_{i,j}]^{2}$$

To achieve the results, we first applied various noises to our ground truth photographs, and then we used various filters to get rid of them.

Here are different medical images on which we conducted our Investigation:

Sample Medical images collected from web sources

Qualitative measurement somehow is not enough to for performance analysis, there for it is important to have quantitative analysis by using performance analysis matric. We know that more PSNR value indicates good quality of result. From the experiments it has been observed that if an image has been distorted by Gaussian Noise, Non-Local Means Filter works well and gives better result. Similarly, Median filter works well to remove Impulse (salt & pepper) Noise. Gaussian Blur filter is fine to remove uniform or quantization noise. After application of different filter on several noisy medical images, PSNR values obtained from the experiments is given below in the table as qualitative performance analysis.

CONCLUSION

With a thorough literature analysis that has contributed sufficient information to the area of image noise processing, this paper examines the image noise and various de-noising strategies. We have utilized three distinct kinds of noise in our tests, and four filters. The results demonstrate that specific filter works significantly well to remove a particular type of noise from noisy image. In addition, we hope to improve our present research work by integrating new, more efficient filters for picture de-noising and add more noise to our trials. However, we are supposed to implement a hybrid filtering techniques combining Non-Local means (NLM) filter followed by Median filter for better quality of de-noised images and its performance analysis. So our next step is to develop a filter that can handle multiple types of noise simultaneously, allowing us to achieve more effective image noise removal techniques.

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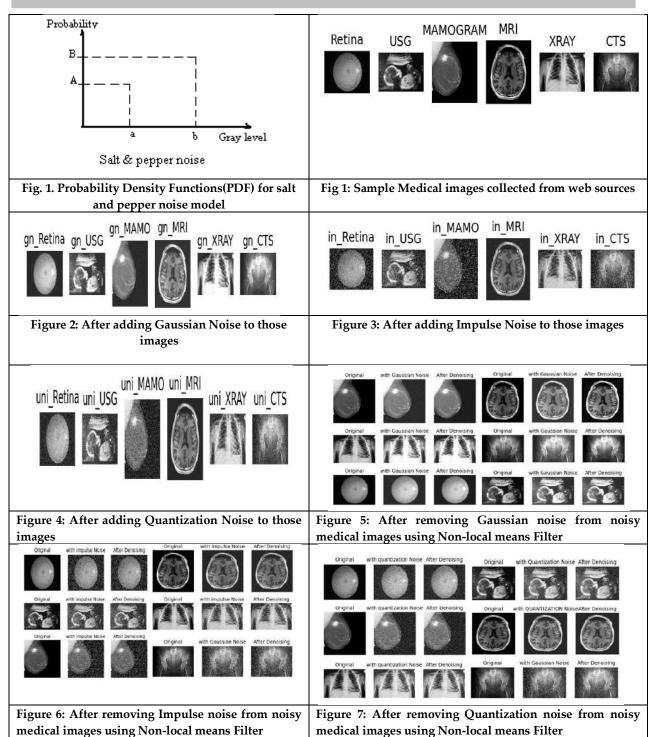


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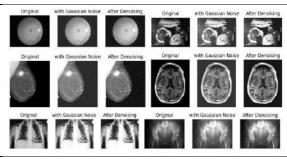
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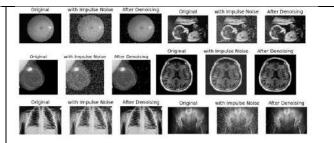
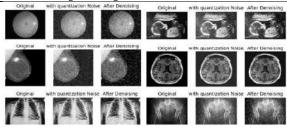


Figure 8: After removing Gaussian noise from noisy medical images using Median Filter

Figure 9: After removing Impulse noise from noisy medical images using Median Filter



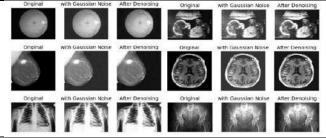
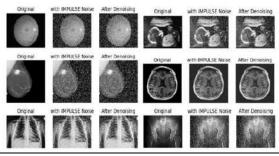


Figure 10: After removing Quantization noise from noisy medical images using Median Filter

Figure 11: After Removing Gaussian Noise from Noisy Medical Images Using Gaussian Blur Filter



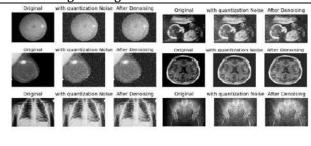
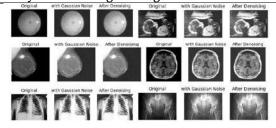


Figure 12: After Removing Impulse Noise from Noisy Medical Images Using Gaussian Blur Filter

Figure 13: After Removing Quantization Noise from Noisy Medical Images using Gaussian Blur Filter



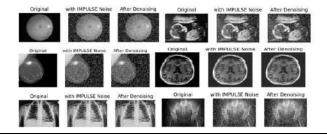
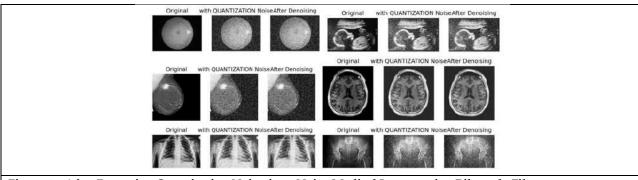


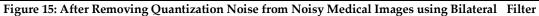
Figure 14: After Removing Gaussian Noise from Noisy Medical Images Using Bilateral Filter

Figure 15: After Removing Impulse Noise from Noisy Medical Images using Bilateral Filter













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RESEARCH ARTICLE

Documentation and Associated Traditional Knowledge of Weed Flora in Challakere, Karnataka

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ABSTRACT

Weeds pose a major threat to agricultural and horticultural crop systems, reducing yields. Weeds have a better ability to compete for resources compared to the main crops of various agro-ecosystems and represent a major obstacle reducing overall yield. Many scientific reports have demonstrated that weeds serve as reservoir or alternative hosts for pathogens in the absence of the main crops. A small attempt has been made to document the weed flora of Challakere in Karnataka. The present work was undertaken during March-2020 to Feb-2021 and nearly 57 species of weeds belonging to 25 families have been documented. I recorded a total of 57 weed species distributed among 48 genera and 25 families. The Asteraceae and Amarantahceae family have the most species (14% species), followed by Euphorbiaceae (11% species) and Poaceae (7% species).

Keywords: Agriculture, weed survey, Challakere, weed management, traditional knowledge

INTRODUCTION

Weeds are a group of specialized plants that have evolved due to massive seed production, aggressive reproduction, high reproductive capacity, and excellent phenotypic plasticity on temporal and spatial scales (Richards et al., 2006). The weed plants are considered unwanted and undesirable at a particular site (Antonio and Meyerson, 2002; Holzner and Numata, 2013). Among the various biological stresses, weeds are known as one of the most detrimental to crop





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production (Einhelling, 1996; Weston and Burrill, 1991). In addition, these weeds provide shelter to numerous pests of crop plants and, thus, indirectly become a cause of many crop diseases (Zimdahi, 2018). The presence of weeds in the agricultural and horticulture fields compete with the native plants to affect yield (Zimdahi, 2018). At the same time, the information on the phenological events of weed is important for formulating effective control and management (Chmielewski, 2013; Kumar et al., 2019). The documentation of weeds in different crop fields is important for the management and control of weeds (Norsworthy et al., 2013; Haq et al., 2021). The identification and documentation of weed invasion are important for formulating various strategies for managing the weeds (Ward et al., 2014). Management decisions for agriculture and horticulture fields are dependent upon the phenological information of crops for improving yield (Chmielewski, 2013). Most of the weeds are effectively well adapted to grow and proliferate in diverse areas (Kuester et al., 2014). The properties of these species of weeds often give them an advantage over more desirable crop species, as they often grow and reproduce rapidly or are short-lived, with seeds remaining in the soil for many years.

MATERIAL AND METHOD

Challakere is the headquarters of a taluk in the Chitradurga district of Karnataka, India. Challakere is located at latitude 14.312°N and longitude 76.651°E. The average altitude is 585 meters (1919 feet). Challakere has a subtropical grassland climate (classification: BSh). The annual temperature in this district is 28.34 °C (83.01 °F), which is 2.37% higher than the average temperature in India. Typical rainfall in Challakere is approximately 84.55 mm (3.33 inches), with 124.03 rainy days per year (33.98% chance of rain). Weed plants were collected during March-2020 to Feb-2021 and identified with the help of flora up to species level (Arora et al.,1976; Sastry et al.,1980; Caton et al.,2004;Cooke,1905;Elmore,1990;Parimala,2011; Gamble,2012).Standard herbarium techniques are followed and specimens are preserved in the Departmental Herbarium for further reference.

RESULTS AND DISCUSSION

In this study I recorded 57 weed species, taxonomically distributed among 48 genera in 25 families (Table 1). 4 families accounting for half of the species and 21 families for the other half. 15 families were represented by single species respectively. The Asteraceae ,Amaranthaceae were the dominant family with 8 species (14%) followed by Euphorbiaceae with 6 species (10.52%) and Poaceae with 4 species (7%). The rest of the species was represented by Fabaceae, Capparidaceae, Solanaceae and other families (Table 1). The monotypic families are Lamiaceae, Plumbaginaceae, Cactaceae, Acanthaceae Apiaceae, and others represented in Table 1. Man breeds plants for yield, while nature breeds plants for survival. Weeds are naturally strong competitors and are resistant to many adversities. The most competitive weeds always tend to dominate. Although agricultural weeds have some disadvantages, there are many more advantages that ensure soil stabilization. Wildlife habitat, feed, and aesthetic qualities. Add organic ingredients, and medicine. The importance of weeds was explained to the local people in a selected area with various examples as given in Table 2. I also surveyed the local area and identified the most widely spread weeds in the selected area. We also documented associated traditional knowledge for these species from traditional practitioners and elder people of the village. Most of the people have a common notion that weeds are just disturbances in the field and the mere thought of weed comes along with an action of uprooting the species. The survey and the awareness regarding the usefulness of the weeds were accepted positively by the people and they were excited to share their knowledge on weeds and its traditional uses. Many weeds were used for medicinal purposes and few were used as hedge plants or as ornamental plants. A literature survey was carried out to support and validate the medicinal properties as claimed by the local people. Most of the weeds have been studied and explored for its medicinal benefits.





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CONCLUSION

In this survey I identified most common 57 weed plants and documented the associated traditionalknowledge from Traditional practitioners and local people. My survey suggests people are less aware of ecological benefits of weeds in soil conservation, greencover and its medicinal benefits. Along with documentation I created awareness about the ecological importance of weeds and their medicinal values through group discussions and meetings. I have done a thorough literature survey of selected weed plant species for their bioactive properties and validated its scientific attributes with recent publications by scientific community. This studyhighlights the importance of weeds and their attributes.

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Table 1: List of Weeds documented

1	2	3	4	5	6	7	8	9
Sl N o	Plant	Scientific Name	Family	Local Name	Affecte d crop	Impact	Landsca pe Habitat	Manageme nt Options
1	Country mallow	Abutilon indicum	Malvaceae	Mallow	All crops	Decreas es the yield of the crop	Terrestri al	plucking
2	Indian copperleaf	Acalypha indica	Euphorbiacea e	Kuppe gida	All crops	Decreas es the yield of the crop	Terrestri al	plucking
3	Bristly starbur	Acanthosperm um hispidum	Asteraceae		All crops	Decreas es the yield of the crop	Terrestri al	plucking
4	Uttaraani	Achyranthes aspera	Amaranthace ae	Uttaraani	All crops	Decreas es the yield of the crop	Terrestri al	plucking
5	Acmella	Acmella oleracea	Asteraceae	Acmella	All crops	Decreas es the yield of the crop	Terrestri al	Removed by hand
6	Grass	Aegilops tauschii	Poaceae	Hullu	some crops	Decreas es the yield of the crop	Terrestri al	plucking
7	Bilikasa	Aerva lanata	Amaranthace ae	Bilikasa	All crops	Decreas es the yield of the crop	Terrestri al	Removing by spraying
8	Goat weed	Ageratum conyzoides	Asteraceae		All crops	Decreas es the yield of the crop	Terrestri al	plucking
9	Flossflower	Ageratum houstonianum	Asteracea	1	All crops	Decreas es the yield of the crop	Terrestri al	plucking
10	Red calico plant	Alternanthera bettzickiana	Amaranthace ae		All crops	Decreas es the yield of	Terrestri al	plucking





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						the crop					
						Decreas					
4.4	Brazilian	Alternanthera	Amaranthace		A 11	es the	Terrestri	1 1.			
11	joyweed	brasiliana	ae		All	yield of	al	plucking			
	, ,				crops	the crop					
						Decreas					
	Smooth joy	Alternanthera	Amaranthace			es the	Terrestri				
12	weed	paronychioides	ae		All	yield of	al	plucking			
		7 3			crops	the crop					
						Decreas					
	Sonna	Alternanthera				es the	Terrestri				
13	Mullu	pungens	Amaranthace	Khaki weed	All	yield of	al	plucking			
	Willia	pungene	ae		crops	the crop	ai ai				
						Decreas					
		Alternanthera				es the	Terrestri				
14	Jal jamba	sessilis	Amaranthace	Jal jamna	All	yield of	al				
		3031113	ae		crops	the crop	ai	plucking			
						Decreas					
						es the					
15	Mullu dantu	Amaranthus	Amaranthace	Mullu dantu	All	yield of	Terrestri				
13	Muliu dalitu	spinosus		Within danitu		-	al	Dhualaina			
			ae		crops	the crop		Plucking			
						Decreas					
		4					T				
16	Datura	Argemone	D	Daturi	All	es the	Terrestri al	plucking			
		maxicana	Papaveraceae		crops	yield of					
					-	the crop					
	D 1	D 1 :				Decreas	- · ·				
17	Red	Boerhavia	Nyctaginacea		All	es the	Terrestri	plucking			
	spiderling	diffusa	e		crops	yield of	al	1 0			
					1	the crop					
						Decreas					
18	Shaggy	Borreria			All	es the	Terrestri	plucking			
	buttonweed	hispida	Rubiaceae		crops	yield of	al	1 6			
					- 'r'	the crop					
						Decreas	_				
19	Buffalo	Bouteloua		Yemme	All	es the	Terrestri	plucking			
-	grass	dactyloides	Poaceae	hullu	crops	yield of	al	Freeding			
					erops	the crop					
						Decreas					
20	Crown	Calotropis	Asclepiadacea	Ekka	All	es the	Terrestri	plucking			
20	flower	gigantean	e	LINK	crops	yield of	al	Pracking			
			6		crops	the crop					
						Decreas					
21	Calotropis	Calotropis	Ascleniadacea	Ekka	All	es the	Terrestri	plucking			
<u></u>	Calottopis	procera	Asclepiadacea	LINKA		yield of	al	plucking			
			e		crops	the crop					
						Decreas	Torrockei				
22	Sicklepod	Cassia tora	E-1	Sicklepod	All	es the	Terrestri	plucking			
	1	Sieniepou	Sieniepou	ыскіероа		Fabaceae	-	crops	yield of	al	prucking
			<u> </u>		1	1					





						the crop		
						Decreas		
							Townstai	
23	Cassia	Cassia fistula	Caesalpiniace	Cassia	All	es the	Terrestri	plucking
		,	ae		crops	yield of	al	1
					1	the crop		
						Decreas		
24	Ondologo	Centella		Ondologo	All	es the	Terrestri	nludina
2 4	Ondelaga	asiatica	Apiaceae <u>.</u>	Ondelaga	crops	yield of	al	plucking
						the crop		
						Decreas		
		Cleome			All	es the	Terrestri	Removing
25	Hurhur	gynandra	Capparidacea	Hurhur	crops	yield of	al	by hand
		gymmum	e		сторь	the crop	ai ai	by raine
						Decreas		
		Cleome		Kolikalina		es the	Towwoodwi	
26	Tick weed		Capparidacea		All		Terrestri	plucking
		pentaphylla	e	gida	crops	yield of	al	1 0
					1	the crop		
						Decreas		
27	Tick weed	Fick weed Cleome viscosa	Capparidacea e		All	es the	Terrestri	plucking
	TICK WCCu					yield of	al	prucking
			e		crops	the crop		
						Decreas		
20	Kanne	Commelina	Commelinace	Kanne	some	es the	Terrestri	
28	soppu	benghalensis	ae	soppu	crops	yield of	al	
				TI	1	the crop		plucking
						Decreas		
		Crotalaria			All	es the	Terrestri	
29	Crotolaria	juncea	Fabaceae	Crotolaria		yield of	al	plucking
		јинсеи	Tabaceae		crops	-	aı	prucking
						the crop		
	ard .	0.1				Decreas	- · ·	
30		Three- Croton aved caper bonplandianum	Euphorbiacea ee		All	es the	Terrestri al	plucking
	leaved caper				crops	yield of		
						the crop		
						Decreas		
31	Bermuda	Cynodon		Garike	All	es the	Terrestri	plucking
31	grass	dactylon	Poaceae	Garike		yield of	al	prucking
		-			crops	the crop		
						Decreas		
	ъ.	Datura		Б.	All	es the	Terrestri	, , ,
32	Datura	stramonium	Solanaceae	Datura	crops	yield of	al	plucking
						the crop		
						Decreas		
					All	es the	Terrestri	
33	Duranta	Duranta erecta	Vorborasass	Durantha				plucking
			Verbenaceae		crops	yield of	al	_
						the crop		
						Decreas		
34	Indian	'	Asteraceae		All	es the	Terrestri al	plucking
01	globethistle				crops	yield of		
						the crop		
					•			





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		T	ı				ı	
35	Wild poinsettia	Euphorbia geniculata	Euphorbiacea e	Euphorbia	All crops	Decreas es the yield of the crop	Terrestri al	plucking
36	Euphorbia	Euphorbia heterophylla	Euphorbiacae	Euphorbia	All crops	Decreas es the yield of the crop	Terrestri al	plucking
37	Asthma herb	Euphorbia hirta	Euphorbiacea e	Euphorbia	All crops	Decreas es the yield of the crop	Terrestri al	plucking
38	Morning glory	Evolvulus alsinoides	Convolvulace ae		All crops	Decreas es the yield of the crop	Terrestri al	plucking
39	Lantana	Lantana camara	Verbanaceae	Lantana, gadhigulabi	All crops	Decreas es the yield of the crop	Terrestri al	Removed by hand
40	Leucas	Leucas aspera	Lamiaceae	Thumbe	All crops	Decreas es the yield of the crop	Terrestri al	plucking
41	Touch me not plant	Mimosa pudica	Mimosaceae	Muttidare muni	All crops	Decreas es the yield of the crop	Terrestri al	plucking
42	Opuntia	Opuntia stricta	Cactaceae	Papaskalli	All crops	Decreas es the yield of the crop	Terrestri al	plucking
43	Parthenium	Parthenium hysterophorus	Asteraceae	Parthenium	All crops	Decreas es the yield of the crop	Terrestri al	plucking
44	Akki hullu	Paspalum floridanum	Poaceae	Akki hullu	All crops	Decreas es the yield of the crop	Terrestri al	plucking
45	Nele nelli	Phyllanthus niruri	Euphorbiacea e	Nele nelli	All crops	Decreas es the yield of the crop	Terrestri al	plucking
46	Plumbago	Plumbago zeylanica	Plumbaginace ae	Plumbago	All crops	Decreas es the yield of the crop	Terrestri al	plucking





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47	Jigali	Portulaca oleracea	Portulacaceae	Jigali	All crops	Decreas es the yield of the crop	Terrestri al	plucking
48	Sida	Sida acuta	Malvaceae	Sida	All crops	Decreas es the yield of the crop	Terrestri al	plucking
49	Heart-leaf sida	Sida cordifolia	Malvaceae	Heart-leaf sida	All crops	Decreas es the yield of the crop	Terrestri al	plucking
50	Ganige gida	Solanum nigrum	Solanaceae	Ganige gida	All crops	Decreas es the yield of the crop	Terrestri al	plucking
51	Mouth fresh	Spilanthes calva	Asteraceae	Mouth fresh	Ragi and paddy	Decreas es the yield of the crop	Terrestri al	Removing by hand
52	Kolkondika mullu	Strobilanthes barbatus	Acanthaceae	Kolkondika mullu	All crops	Decreas es the yield of the crop	Terrestri al	plucking
53	Wild indigo	Tephrosia purpuria	Fabaceae		All crops	Decreas es the yield of the crop	Terrestri al	Removed by using weedicides
54	Puncture vine	Tribulus terrestris	Zygophyllace ae	Neggilu mullu	All crops	Decreas es the yield of the crop	Terrestri al	plucking
55	Tridax	Tridax procumbens	Asteraceae	Tridax	All crops	Decreas es the yield of the crop	Terrestri al	plucking
56	Burbush	Triumfetta rhomboidea	Tiliaceae		All crops	Decreas es the yield of the crop	Terrestri al	plucking
57	Ashwagand ha	Withania somnifera,	Solanaceae	Ashwagand ha	All crops	Decreas es the yield of the crop	Terrestri al	plucking





Ramesh

Table 2: Associated Traditional Knowledge t of Weeds

1	2	3	4	5	6
S1 No	Plant	Scientific Name	Family	Local Name	Associated Traditional Knowledge
1	Country mallow	Abutilon indicum	Malvaceae	Mallow	It used as a traditional medicine as a laxative, emollient, analgesic, antidiabetic, anti-inflammatory and blood tonic agent and also in the treatment of leprosy, urinary disease, jaundice, piles, relieving thirst, cleaning wounds and ulcers, vaginal infections, diarrhea, rheumatism, mumps, pulmonary tuberculosis, bronchitis, allergy, blood dysentery, some nervous and some ear problems.
2	Indian copperleaf	Acalypha indica	Euphorbiaceae	Kuppe gida	Used as anthelmintic, anti- inflammation, anti-bacterial, anti- cancer, anti-diabetes, anti- hyperlipidemic, anti-obesity, anti- venom, hepatoprotective, hypoxia, and wound healing medicine.
3	Bristly starbur	Acanthospermum hispidum	Asteraceae		Used for treatment of jaundice, malaria, vomiting, cephalgias, headache, abdominal pain,convulsions, stomachache, constipation, eruptive fever, snake bite, epilepsy, blennorrhoea, hepato-biliary disorders,malaria, microbial infection and viral infections.
4	Uttaraani	Achyranthes aspera	Amaranthaceae	Uttaraani	Used as medicine, used in the treatment of boils, asthma, in facilitating delivery, bleeding, bronchitis, debility, dropsy, cold, colic, cough, dog bite, snake bite, scorpion bite, dysentery, earache, headache, leukoderma, renal complications, pneumonia, and skin diseases. Used in Poojas during festival
5	Acmella	Acmella oleracea	Asteraceae	Acmella	used as a Used as medicine, analgesic, antiseptic, antioxidant and diuretic Used as fodder
6	Grass	Aegilops tauschii	Poaceae	Hullu	Flowers are used in festival,, it has medicine property
7	Bilikasa	Aerva lanata		Bilikasa	Fodder, used as medicine, used as





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			Amaranthaceae		diuretic with anti-inflammatory, antihelmintic, anti-bacterial and mild analgesic effects. It is used in the treatment of lithiasis, cough, asthma, and headache and as an antidote for rat poisoning
8	Goat weed	Ageratum conyzoides	Asteraceae		Used as common wound and the burned one, antimicrobe, arthrosis, headache, and dyspnea. an antimicrobial, and mouthwash as manure, insecticide, pesticide, herbicide, nematicide, fodder.
9	Floss flower	Ageratum houstonianum	Asteracea		Used as curing fever, paste of leaves is useful in wound healing, essential oil shows cytotoxic effect, antimicrobial and mosquitocidal effects anti- fungal and antibacterial properties
10	Red calico plant	Alternanthera bettzickiana	Amaranthaceae		Used as laxative, galactagogue, antipyretic, wound healing Studies have suggested antibacterial, antioxidant, antioxidant, phytoremediative, mutagenic, hypoglycemic, anti-arthritic, anticancer properties.
11	Brazilian joyweed	Alternanthera brasiliana	Amaranthaceae		used against inflammation, cough, and diarrhea, used as digestive, depurative and diuretic
12	Smooth joyweed	Alternanthera paronychioides	Amaranthaceae		Used to treat hepatitis, tight chest, bronchitis, asthma and other lung troubles. The leaves and shoots boiled and drunk as antihypertensive remedy
13	Sonna Mullu	Alternanthera pungens	Amaranthaceae	Khaki weed	Used as medicine, for constipation with griping, and as an enema for diarrhoea
14	Jal jamba	Alternanthera sessilis	Amaranthaceae	Jal jamna	Flowers are used in festivals, it has medicine property used to treat hepatitis, bronchitis, asthma and other longs problems. The leaves and shoots boiled and drunk as antihypertensive remedy. and milky latex is poisonous
15	Mullu dantu	Amaranthus spinosus	Amaranthaceae	Mullu dantu	Used as Ayurveda medicine, the boiled leaves and roots are used as laxative, diuretic, anti-diabetic,





					antinametic anti anala arang
					antipyretic, anti-snake venom,
					antileprotic, anti-gonorrheal,
					expectorant and to relieve breathing
					in acute bronchitis. It also has anti-
					inflammatory, immune modulator,
					anti-androgenic and anthelmintic
					properties.
					Used as Ayurveda medicine, Seeds
					are poisonous, for the treatment of
16	Datura	Argemone	Papaveraceae	Daturi	several diseases including tumors,
10	Datura	maxicana	1 apaveraceae	Datur	warts, skin diseases, inflammations,
					rheumatism, jaundice, leprosy,
					microbial infections, and malaria.
					Used to treating inflammation,
4.77	D 1 11 11	D 1 ' 1''	N. T		jaundice, asthma, rheumatism,
17	Red spiderling	Boerhavia diffusa	Nyctaginaceae		nephrological disorders, ascites,
					anemia, and gynecological disorders.
					Used to treating urinary infections,
					oliguria, venereal diseases,
					conjunctivitis, hemorrhoids,
	Shaggy button				gallstones, stomach ailments,
18	weed	Borreria hispida	Rubiaceae		internal injuries of nerves, and
	weed				
					kidney, coughs, malaria, internal
					heat, dyslipidemia, and for reducing
		Dantalana			weight.
19	Buffalo grass	Bouteloua dactyloides	Poaceae	Yemme hullu	Used as medicine for piles
					Used to treating skin, digestive,
					respiratory, circulatory and
20	Crown flower	Calotropis	Asclepiadaceae	Ekka	neurological disorders and was used
		gigantean	1		to treat fevers, elephantiasis, nausea,
					vomiting, and diarrhea.
					Used as medicine, fevers,
					rheumatism, indigestion, cough,
21	Calotropis	Calotropis procera	Asclepiadaceae	Ekka	cold, eczema, asthma, elephantiasis,
					nausea, vomiting and diarrhea.
					used in the treatment of leprosy, ring
					worm, flatulence, colic, dyspepsia,
22	Sicklepod	Cassia tora	Fabaceae	Sicklepod	, , , ,
	_			-	constipation, cough, bronchitis and
					cardiac disorders
					Used as medicine, antifungal,
					antiviral, antidiahorreal and
		i	1		antidysentry properties, used for
23	Cassia	Cassia fistula	Caesalpiniaceae	Cassia	l
23	Cassia	Cassia fistula	Caesalpiniaceae	Cassia	treatment of diabetes, asthma,
23	Cassia	Cassia fistula	Caesalpiniaceae	Cassia	treatment of diabetes, asthma, leprosy, thoracic obstructions
23	Cassia	Cassia fistula	Caesalpiniaceae	Cassia	leprosy, thoracic obstructions
		,	-		leprosy, thoracic obstructions Used as medicine, used to treat
23	Cassia Ondelaga	Cassia fistula Centella asiatica	Caesalpiniaceae Apiaceae.	Cassia	leprosy, thoracic obstructions





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25	Hurhur	Cleome gynandra	Capparidaceae	Hurhur	Fodder, used as medicine, used to treat conditions including food poisoning, rheumatism, inflammation, bacterial infections, and especially pain-related conditions such as headache toothache, headache, neuralgia, stomach pain, ear-ache, rheumatoid arthritis, skeletal fractures, colic pain and chest pain
26	Tick weed	Cleome pentaphylla	Capparidaceae	Kolikalina gida	Used to cure diseases such as scurvy. anti-inflammatory, anti-bacterial, antimicrobial, anticancer, antioxidant, antiallergenic.
27	Tick weed	Cleome viscosa	Capparidaceae		Used as medicine for rheumatic arthritis, hypertension, malaria, neurasthenia, stomachic, laxative, diuretic, and anthelmintic and wound healing
28	Kanne soppu	Commelina benghalensis	Commelinaceae	Kanne soppu	Flowers are used in festival, it has medicine property, used to treat leprosy, sore throat, opthalmia, burns, pain and infammation and also used as de pressant, demulcent, emollient and laxative.
29	Crotolaria	Crotalaria juncea	Fabaceae	Crotolaria	Used as medicine for wounds and anti-inflammatory and antinociceptive activity Used to clean the black board
30	Three-leaved caper	Croton bonplandianum	Euphorbiaceaee		Used as fodder, used as a laxative, expectorant, analgesic.
31	Bermuda grass	Cynodon dactylon	Poaceae	Garike	Used as fodder, used as a laxative, expectorant, analgesic.
32	Datura	Datura stramonium	Solanaceae	Datura	Used for medicine, Used to treat back pain, antiepileptic, antiasthmatic, analgesic, antioxidant, antimicrobial, insecticidal, repellent and organophosphate protective effects.
33	Duranta	Duranta erecta	Verbenaceae	Durantha	Used as medicine, diuretics, antidote to treat itches, infertility, pneumonia, malaria, intestinal worms, abscesses and neuralgic disorder. It exhibits antioxidant, antiparasitic,





					antibacterial, antifungal and antiviral
					activities against human pathogens
34	Indian globethistle	Echinops echinatus	Asteraceae	Brahmadhande	used as a stimulant to treat use the term Sexual debility, used to treat different infectious diseases including trachoma, sepsis, typhoid, gonorrhea.
35	Wild poinsettia	Euphorbia geniculata	Euphorbiaceae	Euphorbia	It is used as antibacterial, anti- inflammatory, antimalarial, galactogenic, antiasthmatic, antidiarrheal, anticancer, antioxidant, antiferlity, antiamoebic, and antifungal activities.
36	Euphorbia	Euphorbia heterophylla	Euphorbiacae	Euphorbia	Seeds are poisonous, used to treat ailments such as skin infections, fever, and gastrointestinal disorders.
37	Asthma herb	Euphorbia hirta	Euphorbiaceae	Euphorbia	It is used traditionally for female disorders, respiratory ailments ,cough, coryza, bronchitis, and asthma, worm infestations in children, dysentery, jaundice, pimples, gonorrhea, digestive problems, and tumors.
38	Morning glory	Evolvulus alsinoides	Convolvulaceae		used in Ayurveda as a brain tonic in the treatment of neurodegenerative diseases, asthma and amnesia, treatment of neurodegenerative diseases as brain tonic, amnesia and asthma, epilepsy, nervous debility and loss of memory.
39	Lantana	Lantana camara	Verbanaceae	Lantana, gadhigulabi	Used as fodder, medicine for wound healing, fever treatment, cough treatment, influenza treatment, stomach ache, malaria,
40	Leucas	Leucas aspera	Lamiaceae	Thumbe	Used as fodder, Used for cooking, it shows antifungal, antioxidant, antimicrobial, antinociceptive and cytotoxic activity, antipyretic and insecticide
41	Touch me not plant	Mimosa pudica	Mimosaceae	Muttidare muni	Used as medicine, cure several disorders like cancer, diabetes, hepatitis, obesity, and urinary infections, piles
42	Opuntia	Opuntia stricta	Cactaceae	Papaskalli	Used as medicine, used in the management of diseases that involves oxidative stress, especially





					diabetes, obesity and cancer
43	Parthenium	Parthenium hysterophorus	Asteraceae	Parthenium	Used as medicine, for skin inflammation, rheumatic pain, diarrhoea, urinary tract infections, dysentery, malaria and neuralgia
44	Akki hullu	Paspalum floridanum	Poaceae	Akki hullu	Used as fodder, Used for cooking
45	Nele nelli	Phyllanthus niruri	Euphorbiaceae	Nele nelli	antibacterial, anti-hyperglycemia, anti-viral, diuretic, hepatoprotector, and immunomodulator, role in treating ulcers and urinary tract stones
46	Plumbago	Plumbago zeylanica	Plumbaginaceae	Plumbago	Used as medicine, used in the treatment of stubborn chronic rheumatoid arthritis, skin diseases and tumerous chronic menstrual disorders, viral warts and chronic diseases of nervous system Seeds are poisonous
47	Jigali	Portulaca oleracea	Portulacaceae	Jigali	Used as medicine acting as a febrifuge, antiseptic, vermifuge, anti-inflammatory, antidiabetic, skeletal muscle relaxant, hepatoprotective, anticancer/antitumor, antioxidant, gastroprotective, neuroprotective, wound healing
48	Sida	Sida acuta	Malvaceae	Sida	Used as medicine, used as astringent, tonic and useful in treating urinary diseases and blood disorders, bile, liver and as treatment for nervous diseases Seeds are poisonous
49	Heart-leaf sida	Sida cordifolia	Malvaceae	Heart-leaf sida	It is used to treat bronchial asthma, cold and flu, chills, lack of perspiration, head ache, nasal congestion, aching joints and bones, cough and wheezing, and edema.
50	Ganige gida	Solanum nigrum	Solanaceae	Ganige gida	Used as fodder, Used as Ayurveda medicine to treat pneumonia, aching teeth, stomach ache, tonsillitis, wing worms, pain, inflammation and fever, tumor, inflammation, and also as hepaprotective, diuretic, antipyretic
51	Mouth fresh	Spilanthes calva	Asteraceae	Mouth fresh	Used as medicine, antipyretic, antidiuretic, antiinflammatory, antioxidant, immunomodulatory,





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					hepatoprotective, anticancer and antitoothache, leg pain
52	Kolkondika mullu	Strobilanthes barbatus	Acanthaceae	Kolkondika mullu	Used as fodder, Used during poojas, used as a valid anti-inflammatory and anti-microbial herbal drug
53	Wild indigo	Tephrosia purpuria	Fabaceae		Used as medicine, used to treat impotency, asthma, dyspepsia, hemorrhoids, syphilis gonorrhea, rheumatism, enlargement of kidney and spleen.
54	Puncture vine	Tribulus terrestris	Zygophyllaceae	Neggilu mullu	It has diuretic, aphrodisiac, antiurolithic, immunomodulatory, antidiabetic, absorption enhancing, hypolipidemic, cardiotonic, central nervous system, hepatoprotective, anti-inflammatory, analgesic, antispasmodic, anticancer, antibacterial, anthelmintic, larvicidal, and anticariogenic activities.
55	Tridax	Tridax procumbens	Asteraceae	Tridax	Used as medicine , used to treat bronchial catarrh, diarrhea, dysentery and liver diseases.
56	Burbush	Triumfetta rhomboidea	Tiliaceae		It is used to treat skin disorders or sometimes dysentery. The roots are used in the treatment of conjunctivitis. The leaves have analgesic, anti-inflammatory and antiviral effects. The seeds have powerful purgative virtues.
57	Ashwagandha	Withania somnifera,	Solanaceae	Ashwagandha	It is useful for different types of diseases like Parkinson, dementia, memory loss, stress induced diseases, malignoma and others.





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RESEARCH ARTICLE

Effect of Specific Training Program on Intensity of Pain and Knee Joint Function in Recreational Cyclists with Anterior Knee Pain- A Pilot Study

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ABSTRACT

Studies have found that one of the most prevalent musculoskeletal discomforts in cyclists is knee pain, which can lead to drop off from participating in cycling activity by recreational cyclists. The objective of study was to find out the effect of specific training program on intensity of pain and knee joint function in recreational cyclists with anterior knee pain. An interventional pilot study was performed on healthy recreational cyclists, aged 18 to 50 years, cycling at least 100 km/month, since at least 6 months duration with mild anterior knee pain during cycling, from various cycling clubs and the community of Ahmedabad city. Included participants (n=16) were divided into interventional (training plus ergonomics) and control groups (ergonomics only) randomly. The experimental group was given a specific training program for 8 weeks and the control group was kept in waiting. For measuring intensity of pain Visual Analogue Scale (VAS) and for function Kujala scale were used pre and post 8 weeks. Data was analysed using SPSS 20. Improvement for group A and B were 2.11 ± 0.20and 1.28 ± 0.79 for VAS and 19.37 ±5.69 and 12 ±2.57 for Kujala score respectively. In both groups, the VAS (group A p=0.00004, B p=0.00000007) and Kujala scores (group A p=0.00014, B p=0.00001) were significantly lower after treatment, although the improvement in pain (p=0.04) and function (p=0.000001) were greater in the intervention group. Supplementation of specific training provides benefits concerning the perceived pain during cycling and functional activities in cyclists with anterior knee pain after 8 weeks of treatment.





Manali Kamleshbhai Shah and Megha S. Sheth

Keywords: Recreational cyclist, Anterior knee pain, Injury prevention.

INTRODUCTION

Cycling is a low impact physical activity with high levels of participation and thus it has more popularity than running and other aerobic activities. In India, participation in cycling has increased steadily since the last decade. For purpose of fitness and physical activity, mass participation in recreational and competitive cycling events is increasing leading to increase in amount of cycling related injuries. In cycling overuse injuries are related to monotonous loading and maintenance of static postures for longer period of time. [1] The most common anatomical sites for overuse injury/complaints reported by various studies are the back, knees (ranging from 32% to 60%), neck/shoulder, groin/buttocks, and hands.[2-5] Most of the studies show cyclists with these type of injuries have reported mild pain and haven't led to discontinuation from activity but definitely it has impact on comfort and performance. The prevalence of such injuries in recreational cyclists, suggests that more understanding is needed by cyclists and their health care providers to prevent such injuries by proper education and bike fit and to treat these injuries when they occur.[5,6] The patellofemoral joint is under stressduring bicycling as repetitive lower extremity movement occurs during cycling. Thus, patellofemoral pain (PFP) is found as one of the commonest overuse injury in recreational cyclist.[7, 8]This syndrome can have a negative effect on daily or athletic activities and lead to absence from workplace or stoppage of participation in sports if not treated properly. In sports medicine also, development of practical and effective clinical protocols for PFP and preventive strategies are a central part of clinical research due to high prevalence and chronic nature of PFPS.[10] Studies have also shown many common cycling injuries of the lower extremity are preventable by making changes in cycle setting.[9, 10] and various studies have shown that changes in cycling settings can reduce and prevent knee pain in cyclists.[10, 11]Recently, there are many studies describing exercises to reduce pain and improve function of knee in patients with anterior knee pain. Their focus of treatment is quadriceps strengthening, hamstring and gastrocnemius stretching exercise and use of non-steroidal antiinflammatory drugs.[14-17]but only few of the studies have worked on any exercise protocol for recreational cyclists with anterior knee pain. Thus this study aims to evaluate effect of specific training program in recreational cyclists with anterior knee pain.

METHODS

An interventional pilot study was performed on recreational cyclists from various cycling clubs and the community of Ahmedabad city. The study was approved by the institutional Ethical Committee of Dr. Jivraj Mehta Hospital of Ahmedabad and has been registered in CTRI (CTRI/2021/11/037904). The study included 18 to 50 years old recreational cyclist (n=16) with mild anterior knee pain during or after cycling since at least last 3 months, who were cycling for at least 100 km/month since at least 6 months duration or more. The persons with no pain or moderate to severe pain in knee joint were excluded. Persons diagnosed with osteoarthritis of knee joint based on American College of Rheumatology (ACR) Clinical classification criteria (> Grade I) for osteoarthritis of the knee, [18] with any history of severe musculoskeletal disorders, postural abnormality, limb length discrepancy, unstable cardiovascular or respiratory conditions and neurological diseases were excluded from the study. Based on the literature a specific training program was made for recreational cyclists and was verified by subject experts. Specific training program included various exercises pertaining to lower extremity, core, and pelvic muscle strengthening. It included wall squats, hamstring curls in standing, hip abduction in standing, clamshell exercise, lunges and planks in all 4 sidesprone, supine and both sides. All these exercises except planks, were performed for 3 sets of 10 repetitions for 1 to 4 weeks and progressions made after 4th week, up to 8 weeks. Planks were performed for 3 sets with 15 seconds hold followed by progression after 4th week.[9,19-22] In this study 21recreational cyclist were randomly divided into two groups, interventional and control. Group A (n=10, interventional group) received specific training program for 3 days/ week for 8 weeks, stretching, warm up & ergonomic advice on cycle settings while group B (n=11, control group) received stretching, warm up & ergonomic advice on cycle settings. The procedure of the study was





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explained to all the participants and a written informed consent of the participants was taken prior to the study. For measuring intensity of pain Visual Analogue Scale (VAS) and for function Anterior Knee Pain Scale (AKPS- Kujala score) were taken pre and post 8 weeks of intervention. [17,18] 2 participants from Group A and 3 participants from Group B discontinued before 8 weeks, data of remaining 16 participants were analysed further. Data was analysed using SPSS 20. The t-test for paired samples was used to compare the results of the assessment before and after treatment. The independent t-test was used to analyse between groups differences.

RESULTS

21 recreational cyclist with mild anterior knee pain (VAS ≤ 3.5) during cycling were approached to participate in the study and were randomly divided to interventional (Group A) and control group (Group B). 5 participants discontinued due to personal issues, result of remaining 16 participants, 8 from each group was prepared. Before and after 8 weeks assessment was taken. There were no complaints of adverse effects from either group during 8 weeks. The assessment baseline comparability showed no significant differences between the participants in the two groups with respect to their demographic characteristics, cycling profile (cycling duration, distance & frequency), knee pain duration and side affected. Table 1 shows the baseline characteristics of participants of both the groups. Table 2 shows statistically significant difference in pre and post treatment VAS and AKPS for group A and Group B participants. Chart-1 show difference of pre and post treatment VAS in Group A and Group B while chart-2 shows difference of pre and post treatment AKPS in Group A and Group B. Table 3 shows statistically significant difference in between group analysis.

DISCUSSION

The present study randomly divided 16 recreational cyclists with mild anterior knee pain who were cycling for 100km/month distance and from minimum of 6 months duration in to two groups. The result of present study showed statistically significant improvement in pain and function of knee joint in both the group of participants. The improvement was more following specific training program in reducing pain during cycling and improving knee join function in recreational cyclists with mild anterior knee pain. In support to result of present study, C. San Emeterio et al performed an experimental study on female road cyclists who were injury free from at least 3 months. 24 female cyclists were randomly allocated into two groups, one group received core training program including 6 different core exercises (short foot exercise in rotation, balance, anterior plank with leg raises, dead bug, bird-dog and bridge single leg) for 3 days a week for 8 sessions in addition to their regular training sessions. They concluded that lumbopelvic stability training for 8 weeks enhances muscular endurance and core stability in female road cyclists.[22]These results are similar to as seen in the present study. Another study by Pascal E et.al, developed an athletic injury prevention program targeting the most common athletics injuries. It included 8 exercises addressing core, hip, knee, and pelvic muscles strengthening, stretching, and balance exercises 3 days a week for 12 weeks. They found that such injury prevention program can effectively help to reduce occurrence of injury complaints that would restrict an athlete's participation in athletics in the short term. [19] The present study showed improvement in symptoms. Follow up can be done to see if injuries are prevented in the long term. In our study exercise protocol included weight bearing strengthening exercises for hip and knee joints. This was supported by experimental studies performed by M.C. Saad et al. and AsifM et.al who demonstrated both hip and quadriceps strengthening improved lower extremity kinematics and but weight bearing exercises for hip were more effective.[17,25] Ruckstuhl L et.al have shown that effect of core strengthening (planks in all 4 directions) decreases low back pain and improves cyclist's performance.[26]Van Zyl E et.al and Shah MK et.al have shown in their review including strengthening of knee, hip, pelvis and core muscles and flexibility of hamstring, IT band, and calf muscles in management of patell of emoral pain can improve knee pain. [7,16] This study has assessed only one functional scale as a measurement, other objective tests can be performed to find improvement in function of the knee in recreational cyclists. For future studies, long term effect of this exercise protocol can be explored to see whether this program also helps to prevent knee pain in recreational cyclists. As only few studies had focused on exercises for core, hip and knee strengthening





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on pain and function in recreational cyclists with knee pain, present study was done to see efficacy of specific training program on pain and knee joint function in intervention group of recreational cyclists. In summary, supplementation of specific training provided benefits concerning the perceived pain symptoms during cycling and functional activities in cyclists with anterior knee pain after 8 weeks of treatment. In our suggestion, this exercise protocol should be used by recreational cyclists and health care providers searching for treatment to improve pain and function for anterior knee pain.

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ETHICS COMMITTEE APPROVAL

The study is approved by the institutional Ethical Committee of Dr. Jivraj Mehta Hospital of Ahmedabad.

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Table 1: Baseline Characteristics of Participants

Demographics	Group A (n=8)	Group B (n=8)	P value
Age (years)	33.4 ± 8.47	34.6 ± 11.6	0.81*
Gender			
Male	5	7	0.17*
Female	3	1	
Cycling duration (months)	44.625 ± 32.86	53 ± 30.45	0.60*
Cycling distance (km/month)	318.75 ± 164.61	282.5 ± 174.08	0.71*
Cycling frequency (days/week)	3 ± 1.85	3.125 ± 1.95	0.90*
Knee pain duration (months)	6.125 ± 4.32	5.25 ± 3.99	0.69*
Knee pain intensity (VAS at 0 week)	3.07 ± 0.09	3.1 ± 0.05	0.94*
Knee function (AKPS at 0 week)	69.5 ± 5.88	67.13 ± 6.89	0.51*
Side affected			
Right	4	4	0.59*
Left	2	1	0.397
Bilateral	2	3	





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*Statistically no significant difference with P >0.05.

Table 2: Within Group Analysis

Group		Pre test	Post test	P value
A	VAS	3.07 ± 0.09	0.96 ± 0.10	0.000003*
A	AKPS	69.5 ± 5.88	88.9 ± 4.38	0.00000007*
D	VAS	3.1 ± 0.05	1.76 ± 0.68	0.003*
В	AKPS	67.13 ± 6.89	79.13 ± 7.51	0.0000001*

^{*}Statistically significant difference with P < 0.05.

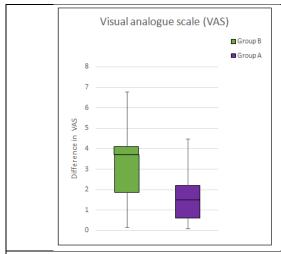
Here, VAS= Visual Analogue Scale and AKPS = Anterior Knee pain Scale

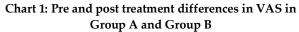
Table 3: Between Group Analysis

	Group A	Group B	P value
Difference in Pain (VAS)	2.11 ± 0.20	1.28 ± 0.79	0.04*
Difference in function (AKPS)	19.37 ± 5.69	12 ± 2.57	0.00001*

^{*}Statistically significant difference with P < 0.05.

Here, VAS= Visual Analogue Scale and AKPS = Anterior Knee pain Scale





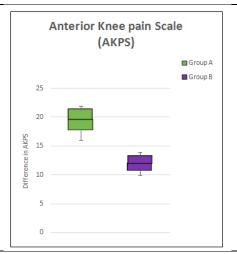


Chart 2: Pre and post treatment differences in AKPS in Group A and Group B





REVIEW ARTICLE

Pharmacovigilance in India: Current Context and Future Perspective

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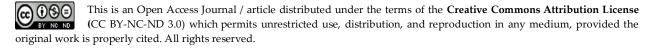
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ABSTRACT

Pharmacovigilance is an essential component of the drug regulatory system. With a growing population and new pharmaceuticals entering the market on a daily basis, India requires an efficient pharmacovigilance system. Pharmacovigilance is critical in the discovery, assessment, and publicization of adverse drug reactions using various methodologies. Adverse drug reactions cause substantial harm to patients and can potentially result in morbidity and fatality. Pharmacovigilance databases aid in the promotion of safe drug use and the safeguarding of public health. This article highlights the most recent advancements of well-established pharmacovigilance systems of India, and future prospects and perspectives to be adapted in widening the horizon of the existing pharmacovigilance structure in India.

Keywords: Adverse Drug Reactions, Drug Safety, Pharmacovigilance, Public Health, Rational Use, Healthcare Costs, Definite Outcomes.





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INTRODUCTION

Pharmacovigilance (PV) began around 170 years ago, although it was not yet called such. It is an organized activity in the professional health area with significant social and commercial repercussions that aims to evaluate pharmacological risk/benefit ratios, improve patient safety, and quality of life. The concept of drug safety, sometimes known as "Medication Safety," is not new, particularly in the sphere of health in affluent countries. India has one of the world's largest drug-consuming populations. In the Indian pharmaceutical market, there are between 60,000 and 80,000 drug brands that are irrationally prescribed and misused [1]. This could be owing to a lack of pharmaceutical safety measures and regulatory failures. Misuse and incorrect prescribing are key causes of adverse drug reactions (ADRs), which are one of the leading causes of mortality and morbidity, unexpected hospitalization, and higher healthcare costs worldwide [2-5]. Thus, early detection of ADRs is critical for both government and non-government health care organizations. The World Health Organization (WHO) defines ADRs as a response to a drug which is noxious and unintended and which occurs at doses normally used in man for prophylaxis, diagnosis, or therapy of disease or for the modification of physiologic function [6]. Pharmacovigilance is the science of collecting, monitoring, researching, assessing, and evaluating information from healthcare providers and patients about the adverse effects of medications, biological products, blood products, herbals, vaccines, medical devices, traditional and complementary medicines with the goal of identifying new information about product hazards and preventing patient harm. The task of maximizing medication safety while preserving public trust has become increasingly challenging. Pharmaceutical and biotechnology firms must not only monitor, but also assess and manage drug risk proactively throughout a product's lifespan, from development through post-market [7].

HISTORICAL OVERVIEW OF PHARMACOVIGILANCE

Pharmacovigilance began 169 years ago, on January 29, 1848, when a little girl (Hannah Greener) from the north of England died after getting chloroform anesthesia prior to the removal of an infected toenail. Sir James Simpson discovered chloroform to be a safer and more potent aesthetic and introduced it into therapeutic practice. To comprehend what happened to Hannah, the causes of her death were studied, but it was impossible to determine what killed her. She most likely died as a result of a fatal arrhythmia or pulmonary aspiration [8]. More than 100 persons died in the United States in October 1937 as a result of the antibiotic sulphanilamide. These deaths were caused by the inclusion of diethylene glycol (DEG), an excipient used as a solvent for the active substance, rather than the active ingredient itself. DEG was meant to be inactive, having no therapeutic benefits; however, the toxic ingredient was what caused the fatal adverse effects. The corporation stated they did not anticipate these side effects, which was correct because they did not do animal trials before marketing the medicine [9]. Douthwaite proposed in 1938 that acetylsalicylic acid (ASA) could cause melena [10]. The results of the ASA gastrointestinal toxicity trial were mixed. However, it was demonstrated in 1955 that ASA can cause gastrointestinal disorders, and it is now prohibited in people with gastrointestinal ulcers [11]. Following the tragedy of Thalidomide, a major shift in European Pharmacovigilance occurred in 1961. Dr. McBride, an Australian physician, suggested a link between congenital deformity of newborns and thalidomide in a letter to the editor of the Lancet Journal. In fact, he discovered that the incidence of congenital abnormalities (1.5%) in neonates had increased by up to 20% among women who had taken thalidomide during pregnancy [12-14].

EVOLUTION OF PHARMACOVIGILANCE SYSTEM

Monitoring pharmaceuticals and their associated adverse drug reactions is a key job of all Health-Care Professionals (HCPs), as ADRs are a major cause of hospital admissions in various parts of the world, and hence PV is an essential component of health-care systems worldwide [15]. It wasn't until the Thalidomide accident in 1961 that the first systematic worldwide attempts to address drug safety issues were launched. Taking serious note of it, in 1968, WHO launched a Programme for International Drug Monitoring (PIDM) [16]. The Uppsala Monitoring Centre (UMC) in Sweden serves as a WHO-Collaborating Centre (WHO-CC) and is in charge of International Drug Monitoring, with technical advice and support from WHO. There are currently 139 WHO-UMC member nations that have taken on the obligation of reporting ADRs to UMC, as well as 31 associate member countries that are in the early phases of





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creating own PV systems [17]. UMC has created web-based technologies such as VigiFlow® and VigiLyze® to collect information on the safety profiles of medicines. These tools can help with drug safety information (DSI) data entry, retrievalv, and analysis. Member countries can assess and disclose risk-benefit profiles of their medicinal products using these methods. UMC also assists member countries in building a culture of PV practice through consulting and training [18].

HISTORY OF PHARMACOVIGILANCE IN INDIA

In India, consideration for ADR surveillance emerged rather late, as there was previously no idea of medication surveillance in the country. Despite the fact that PV is still in its infancy, it is not new to India. It wasn't until 1986 that a few physicians, mostly from academic institutions, urged for more attention to be paid to the potential side effects of prescription medications and rational medication prescribing. This resulted in the establishment of the first ADR monitoring program, which consisted of 12 regional centers, each covering a population of 50 million people, however it was a failure [19]. Nothing much transpired until 1997, when India formally joined the WHO ADR Monitoring Program in Uppsala, Sweden. A National Pharmacovigilance Center in the Department of Pharmacology, All India Institute of Medical Sciences (AIIMS), New Delhi, and two WHO special centers in Mumbai (KEM Hospital) and Aligarh (JLN Hospital, Aligarh Muslim University) were identified as ADR monitoring centers. The primary function of these facilities was to monitor ADRs to pharmaceuticals sold in India. However, they were inoperable since information regarding the requirement to report ADRs and the tasks of these monitoring centers never reached prescribers, and there was a lack of government funding. This initiative was equally unsuccessful, thus the WHO-sponsored and World Bank-funded National Pharmacovigilance Program (NPVP) for India was launched on January 1, 2005 [20]. The National Pharmacovigilance Advisory Committee, situated at Central Drugs Standard Control Organization (CDSCO), was to manage the NPVP, which was founded in January 2005. The committee and the Uppsala Monitoring Centre in Sweden were to receive information from two zonal centers: the South-West zonal center (located in the Department of Clinical Pharmacology, Seth GS Medical College and KEM Hospital, Mumbai) and the North-East zonal center (located in the Department of Pharmacology, AIIMS, New Delhi). Three regional centers would report to the Mumbai center, while two would report to the New Delhi center. Each regional center, in turn, would have multiple peripheral centers reporting to it (a total of 24). The program had three broad goals. The program's short-term goal was to establish a reporting culture, the intermediate goal was to engage a significant number of healthcare professionals in the system in information dissemination, and the long-term goal was for the program to be a benchmark for worldwide drug monitoring. This program, however, also failed [21].

PHARMACOVIGILANCE SYSTEM IN INDIA

Pharmacovigilance in India began in 1986 with the establishment of a formal adverse drug reaction monitoring system under the supervision of India's drug controller. India attempted but failed to join the WHO Programme for International Drug Monitoring in 1998. Later, in 2005, the National Programme of Pharmacovigilance was created, and in 2010 it was renamed the Pharmacovigilance Programme of India (PvPI) [22,23]. Steps were done to ensure that India has a strong pharmacovigilance system. The National Coordination Centre was relocated from New Delhi to Ghaziabad to the Indian Pharmacopoeia Commission (IPC). The PvPI seeks to protect the Indian population's health by ensuring that the benefits of medicines outweigh the hazards associated with their use. With 250 PvPI-established adverse drug monitoring centers across India and training for healthcare personnel, the culture of reporting ADRs has gained amazing success. In addition to detecting inferior drugs and prescribing, dispensing, and administration problems, the program works hard to develop trust between the physician and the patient, ultimately boosting patient safety and public trust in the country's health system. The IPC-PvPI has just been designated as a WHO Collaborating Centre for Pharmacovigilance in Public Health Programs and Regulatory Services. Despite these accomplishments, the PvPI has various obstacles, including the monitoring of generic pharmaceuticals, biosimilars, and disease-specific ADRs of antidiabetic, cardiovascular, and antipsychotic drugs, as well as the ongoing process of increasing awareness. Simultaneously, the PvPI is attempting to address additional issues such as counterfeit pharmaceuticals, antimicrobial resistance, and surveillance during mass vaccinations and other governmental programs.





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AIMS OF PHARMACOVIGILANCE[24]

- 1. To Increase public protection from the new drugs.
- 2. To contribute to assessment of benefit efficiency and risk of medicines.
- 3. Endorse healthy communication to the community.
- 4. To promote rational and safe use of medicines.
- 5. Efficacy of drug and their monitoring about adverse effects of drugs.
- 6. Pharmacovigilance keeps way of any drastic effects of medicines. Improve public health and safeties in relation to the use of promote understanding, education and clinical training in pharmacovigilance.

GOALS OF PHARMACOVIGILANCE PROGRAMME

Short term goals

- 1. To develop and implement pharmacovigilance system in India.
- 2. To encourage the health professionals in reporting of adverse drugs, vaccines, medical devices, and biological products.
- 3. Collection of case reports and data.
- 4. All MCI approved medical colleges conducted the programs.

Long term goals

- 1. To expand the pharmacovigilance programme to all hospitals and centers public health programs located in India.
- 2. To make ADR reporting mandatory for healthcare professionals.
- 3. To develop and electronic reporting system.

CDSCO REGULATORY MEASURES: NCC-PVPI RECOMMENDATIONS

In India, it is critical for PvPI to play a significant role in promoting safe medication use in order to avoid ADRs. PvPI has been responsible for making people aware of numerous ADRs caused by pharmaceutical products since its recasting; this system also encourages people in India to come forward and report ADRs. PvPI, which has 311 AMCs across India, supports correct reporting of ADRs through ADR-reporting forms. The data obtained from the suspected ADR-reporting forms is used to complete ICSRs online in the WHO database, i.e., VigiFlow®. The data collected from the suspected ADR-reporting forms is used to complete individual case safety reports (ICSRs) online in the WHO database, i.e., VigiFlow®. ADRs are reported to PV Associates at various AMCs by the Coordinator/Deputy Coordinator; these reports are then analyzed and appraised for causality by a team of doctors, pharmacologists, and PV Associates at each AMC. Furthermore, the PV Associate at each AMC delivers these reports to NCC in the form of ICSRs using VigiFlow® software. These ICSRs are then processed, quality-assured, and evaluated depending on the information provided before being submitted to UMC, Sweden [22,25].

ADVERSE DRUG REACTIONS REPORTING TOOLS

The communication and reporting of drug safety information between HCPs, patients, (marketing authorization holder) MAHs, and PV officials is critical for ADR reporting. To make this procedure easier, (National Coordination Center) NCC-PvPI, IPC has created a number of ADR-reporting tools.

Adverse Drug Reactions Reporting Forms

NCC-PvPI has developed ADR reporting forms for the convenience of Indian citizens, which are available on the IPC website (www.ipc.gov.in). The paperwork can be downloaded, filled out, scanned, and mailed, or faxed to a nearest adverse drug reaction monitoring center (AMC) or directly to NCC. If the forms arrive at the NCC, they are sent to the nearest AMC, where a PV associate contacts the person who reported the AEs (adverse events). After gathering adequate information from the patient, the PV associate sends the report back to NCC as ICSRs after filling out the necessary elements.





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These forms are offered in two variations. The first is a red-colored English imprint suspected ADR reporting form for HCPS voluntary reporting (Version 1.3). The second is a blue consumer reporting form for voluntary reporting by consumers/patients (Version 1.0). Given India's diversity, this form has been written in ten vernacular languages to facilitate consumer reporting [26]. These forms are also available in the National Formulary of India, on the CDSCO website, and as paper copies at neighboring AMCs where local PV associates assist consumers in filling out the reporting form, which is then sent to NCC for review.

Mobile Application

In this technologically evolved, modernized environment, PvPI created the "ADR-PvPI" mobile application as an ADR reporting tool. With the increased usage of smart phones and mobile applications, health-care services can be made available to the public more swiftly. The "ADR-PvPI" program is available on the Android platform, with intentions to expand to iOS soon, and may be downloaded on any smart phone that supports Android v5.0 or higher [27]. Since the launch of this mobile application in September 2017, HCPs have been more aware of the importance of reporting ADRs [28].

Toll-free number (Helpline)

Adverse drug reactions can be reported directly to NCC-PvPI via a toll-free number, 1800-180-3024. Since its inception on October 11, 2013, the PvPI helpdesk has received a steady stream of ADR reports. During business days, i.e., Monday-Friday (between 9:00 AM and 5:30 PM), calls are mostly answered in English and Hindi. This toll-free number has been printed on in-patient and out-patient departmental prescription slips at hospitals throughout India [29]. PV officials not only investigate ADRs reported by patients, but also aid them with any prescription or dose regimen that is uncertain or deceptive. With a wide range of callers, this ADR-reporting tool is one of the simplest ways to verbally contact with patients and get the relevant AE facts. These facts are relayed to a local AMC, and PV personnel then communicate with the patient to gather the necessary information, which is subsequently entered into VigiFlow® [30].

Non-Adverse Drug Reaction Monitoring Centre's Voluntary Reporting

The PvPI also encourages non-AMCs to report adverse events (AE) using the following E-mail: icsr.nccpvpi@gmail.com or by mail. They may also notify neighboring AMCs about the AEs.

PHARMACOVIGILANCE OF HERBAL PRODUCTS IN INDIA

Herbs have been used as medicine for as long as recorded history. According to some authors, the first known usage of herbs for medical therapy occurred more than 4000 years ago [31]. This type of medical treatment was developed in China and India. The interactions between the body and its surroundings are the focus of traditional Chinese medicine. A mix of treatments, including herbs, acupuncture, and massage, is then prescribed. Since 3000 BC, traditional Indian medicine has been practiced. Traditional Indian medicine includes Ayurvedic medicine. Medicinal herbs serve a vital purpose and are the foundation of almost all traditional medical systems. Misuse of the wrong medicinal plant species, incorrect dosing, errors in the use of herbal medicines by healthcare providers and consumers, interactions with other medicines, and the use of products contaminated with potentially hazardous substances such as toxic metals, pathogenic microorganisms, and agrochemical residues can all lead to adverse events [32]. To ensure consistency in the naming of herbs in adverse reaction (AR) reports, the WHO Collaborating Centre for International Drug Monitoring has recommended the use of proper scientific binomial names for herbs used in medicine, including the use of such names in the coding of AR reports (where this information is available) [33].

PHARMACOVIGILANCE OF VACCINES IN INDIA

Vaccine pharmacovigilance is crucial for promoting vaccine safety among recipients. The Adverse Events Following Immunization (AEFI) surveillance program was established in India in 1986 to document suspected adverse events following immunization, and the AEFI surveillance guideline has been modified on a regular basis since then, with the most recent amendment in 2015 [34].





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Vaccines are a minor component of pharmaceutical products, yet they play an essential part in current health-care delivery. Vaccination has saved millions of lives by preventing many serious illnesses and disabilities around the world [35]. Diseases that previously wreaked havoc on humanity by inflicting severe damage in terms of mortality and morbidity are now either eradicated or tamed as a result of the widespread use of vaccinations [36]. The WHO defines vaccination as a biological preparation that induces the body's immune system to trigger an immunological response to a specific virus [37]. Vaccines are commonly thought to be safe, but like any other drug, they are not completely safe, and adverse events (AEs) can occur after they are administered [38-40]. India is one of the world's leading makers and exporters of vaccinations. Aside from that, India has one of the world's largest immunization programs (Universal Immunization Program [UIP]) for the prevention of vaccine-preventable diseases, targeting around 27 million newborns and 30 million pregnant women each year [26]. It is nearly impossible to discover all possible AEs throughout the various phases of the clinical trial; thus, post-marketing surveillance (PMS) plays an important role in evaluating the vaccine's safety. The Government of India launched the AEFI surveillance program in 1986, shortly after the start of UIP in 1985 [41]. The major goal of launching this program was to detect AEFI, manage it quickly, and take appropriate measures to prevent such incidences in the future. The AEFI, on the other hand, was unsatisfactory for a long time [41]. In light of this, the Government of India developed the first operational guideline for AEFI in 2005, with technical assistance from WHO, and distributed it to medical officers across the country in order to strengthen and systematize the AE reporting system. This guideline was changed and modified in 2010. Meanwhile, national and state AEFI committees were established in 2008 to improve AEFI reporting, and they were restructured in 2013 to offer substantial knowledge and a broader perspective [42]. The National AEFI Secretariat and National AEFI Technical Collaborating Centre were established in the same year, respectively, at the Immunization Technical Support Unit of the Health and Family Welfare Department and Lady Hardinge Medical College (LHMC), New Delhi, providing technical oversight and support. In 2015, the Government of India issued another amended AEFI guideline in agreement with the WHO/CIOMS (Council for International Organizations of Medical Sciences) guideline, furthering the objective of effective vaccine implementation and surveillance [43,44].

PHARMACOVIGILANCE OF VETERINARY MEDICINES IN INDIA

Veterinary pharmacovigilance (PV) is critical for medicines used to treat disease in animals. It becomes even more critical when these animals are employed to produce food. ADRs have a direct influence on animals and an indirect one on humans, for example, through milk and other animal-producing food products. The Central Drugs Standard Control Organization regulates veterinary pharmaceuticals in India [45].

CONTAINMENT OF ANTIMICROBIAL RESISTANCE IN INDIA: ROLE OF PVPI

The misuse of antimicrobials has emerged as a major public health threat. This has played a significant role in the establishment of antimicrobial resistance (AMR) among all pathogens over the last two decades. A multi-country survey done by the WHO across Southeast Asia in 2015 highlighted many gaps in knowledge and awareness concerning the appropriate use of antimicrobials and AMR [46]. To address the issue of antimicrobial resistance, India established a "National Program on Containment of Antimicrobial Resistance" as part of the Government of India's (GoI's) 12th five-year plan (2012-2017) [47]. This national program highlighted its activities as surveillance for AMR containment in various geographical regions, development and implementation of national infection control guidelines, training and capacity building of professionals in relevant sectors, promotion of rational antibiotic prescribing/use, and development of a National Repository of Bacterial Strains/Cultures [48]. The Indian drug regulatory organization, the Central Drugs Standard Control Organization (CDSCO), has established Schedule H1 in India to avoid indiscriminate use of high-end antibiotics. This schedule, which went into effect in March 2014, covers 24 antibiotics (third and fourth generations) that were sold OTC (over the counter) in India. The medications covered under schedule H1 are now only available for purchase with a valid prescription from a health-care practitioner [49]. Designing and deploying comprehensive surveillance systems that are practicable, cost-effective, and inter-connected with the national health-care system, on the other hand, is a difficulty [50]. IPC recently cooperated with the Department of Microbiology, Nizam Institute of Medical Sciences, Hyderabad, and the National Institute for Research in Tuberculosis, Chennai, to improve understanding of antibiotic resistance and promote rationing of





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antimicrobials NCC-PvPI. PvPI has concentrated its efforts on enhancing patient safety through antimicrobial pharmacovigilance and has advised health-care providers to use evidence-based medicine [51].

CHALLENGES OF PHARMACOVIGILANCE IN INDIA

The PVPI's main challenge is the huge underreporting of negative outcomes. There are several causes for this, including a lack of medical understanding in pharmaceutical administration, a lack of skilled resources, and broad pharmacovigilance awareness. The key challenges are infrastructure, uniformity in regulatory inspections, and the technocracy of PV professionals in establishing a solid system [52]. Lack of harmonization and high attrition rates. Furthermore, with increasing clinical research and PV outsourcing work being performed in India, it has been profitable for the DCGI (Drug Controller General of India) to invest in a comprehensive PV system to allow assessors and decision makers to review safety data and make regulatory judgments without relying on other countries. However, ADRs are not often recognized by clinicians upon admission, and in many cases, ADRs are the cause of mortality. ADRs have a substantial financial influence on the healthcare system [53].Previously, India's regulatory agencies and pharma corporations focused their safety judgments on long-term use experiences[54]. In recent years, Many Indian corporations have increased their investment in research and development in recent years, strengthening their potential to create and market new pharmaceuticals through their own research activities. Once a product is commercialized, new information is generated that may affect the product's benefit-risk profile.

FUTURE PROSPECTS

As future prospects improve, PV systems capable of detecting new ADRs and enacting regulatory actions are required to preserve public health, enable patient-centered evidence-based clinical and pharmacotherapeutic decision making, and facilitate seamless communication between healthcare providers and consumers [55]. PV techniques must also be able to identify which patients are likely to experience an ADR. The PV approach, as a source of information, would be congruent with the increased patient involvement in medication safety. The PV may be useful in identifying individual risk factors for the development of specific ADRs. PV must focus on patients as a source of information in the future, in addition to more traditional groups such as health professionals [56]. Currently, the DCGI should move fast to improve PV by incorporating Good Pharmacovigilance Practice (GPP) into processes and procedures to help assure regulatory compliance and improve clinical trial safety and post-marketing surveillance. If medicines are to be used safely, a well functioning PV system is required. Healthcare experts, regulatory bodies, pharmaceutical businesses, and consumers will all profit from it. It assists pharmaceutical corporations in risk-monitoring their medications [57].Post-marketing PV is currently a difficult and time-consuming process for both the industry and regulatory regulators.

FUTURE PERSPECTIVES

The NCC has directed the regional training centers (RTCs) to provide advanced level training for all AMC workers in their respective regions, as well as one continuing medical education (CME) in pharmacovigilance at an AMC in their territory, in order to raise healthcare professionals' awareness of ADR reporting. All Medical Council of India-approved institutions will be enrolled in the PvPI in the near future. As the WHO Collaborating Center for Medicines and Vaccine Safety in the South East Asia Region was recognized at the 38th Annual Meeting of National Pharmacovigilance Centers participating in the WHO program for international drug monitoring, the IPC plans to initiate and coordinate with countries in the region for potential signals from the built safety database. NCC is developing and supporting an efficient method for ADR reporting, such as an online reporting system.

CONCLUSION

India is the world's fastest expanding pharmaceutical market, which offers considerable prospects for drug development and marketing. As a result, pharmaceutical rules in this region are gaining traction among pharmaceutical businesses all over the world. In India, a dynamic PV network system with an efficient and sensible operation approach is critical. Nonetheless, PV initiatives in India are at an early stage comparable to other nations,





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owing only to underreporting of ADRs. However, in the future, PvPI may serve as a large dashboard for India's ADR reporting culture, as it works tirelessly to improve patient and drug safety.

ABBREVIATIONS

PV: Pharmacovigilance;

ADRs: Adverse Drug Reactions; **WHO**: World Health Organization;

DEG : Diethylene Glycol; ASA :AcetylSalicylic Acid; HCPs : Healthcare Professionals ;

PIDM: Programme for International Drug Monitoring;

UMC: Uppsala Monitoring Centre;

WHO-CC: World Health Organization-Collaborating Centre;

DSI: Drug Safety Informations;

AIIMS: All India Institute of Medical Sciences; **NPVP**: National Pharmacovigilance Program;

CDSCO: Central Drugs Standard Control Organization;

PvPI: Pharmacovigilance Program India; IPC: Indian Pharmacopoeia Commission; ICSRs: Individual Case Safety Reports; MAHs: Marketing Authorization Holders; NCC: National Coordination Center;

AMC: Adverse Drug Reaction Monitoring Center;

AE's: Adverse Events;

AEFI's: Adverse Event Following Immunizations;

UIP: Universal Immunization Program; **PMS**: Post-marketing Surveillance;

CIOMS: Council for International Organizations of Medical Sciences;

AMR: Anti-microbial Resistance;

GoI: Government of India;

DCGI: Drug Controller General of India; **GPP**: Good Pharmacovigilance Practice; **RTC's**: Regional Training Centers.

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RESEARCH ARTICLE

on the Phytoplankton Diversity of Selected Ponds in Radhapuram Taluk, Tirunelveli District

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ABSTRACT

Temples are the centres of worship for Hindus and Sikhs. Hindu temples in Tamil Nadu and other states of India having their vicinity of ponds which are holy and called temple ponds. The present study was conducted at two ponds of Radhapuram taluk in Tirunelveli district. The samples were collected from the selected ponds such as Murugan Kovil (P1) and Sivan Kovil (P2) from December 2019 to March 2020. The study focussed on the phytoplankton analysis of the water samples from the pond. A total of 61 algal species were observed during the study period. Out of the total species, 28 species belonged to Chlorophyta, 13 species were belonged to Bacillariophyta, 7 species belonged to Cyanophyta and 3 species belonged to Euglenophyta. From this study, it can be concluded that the temple ponds of Murugan Kovil and Sivan Kovil of Radhapuram taluk of Tirunelveli district have a great diversity with several algal taxa.

Keywords: Phytoplankton, temple pond, Radhapuram Taluk.





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INTRODUCTION

Water is one of the most abundant compounds in earth approximately covering three-fourth of the earth's surface. Majority of water available on earth is saline in nature; only a small quantity exists as fresh water. Ponds have been used since time immemorial as a traditional source of water supply in India. The ponds and lakes are more productive ecosystems and their importance as life supporting system in controlling water cycles and cleaning the environment has acknowledge by wetland experts worldwide [1]. Temple tanks are examples of pond ecosystem. It has its own biotic and abiotic compounds. It is rich flora and fauna like any other freshwater ecosystem. Algae are the primary producers or photosynthetic thallophytes, usually microscopic, unicellular, and colonial or multi cellular organisms which perform the maximum quantum of photosynthetic activity than any living organisms in this world. Many forms spread throughout the water body and cause turbidity of water and algal blooms [2]. Phytoplankton are microscopic plants containing chlorophyll a, that float or swim on the upper of the water or are suspended in the water column, where they are dependent on sunlight for photosynthesis. They are the major primary producer in many aquatic systems forming the first tropic level in the food chain and are the important food source for other organisms of that system [3]. The importance of plankton communities, in the tropic dynamics of fresh water ecosystems has long been recognized, as these organisms, not only regulate the aquatic productivity by occupying almost middle position in food chain but also indicate environmental status in a given time [4]. They respond quickly to environmental change and are used to assess the ecological status of water body. Phytoplankton has been used recently as an indicator to observe and understand changes in the ecosystem because it seems to be strongly influenced by climatic features [5,6].

MATERIALS AND METHODS

The selected site for the study was two temple ponds (Pond 1-Muurugan Kovil, Valliyoor; Pond 2- Sivan Kovil, Panagudi) of Radhapuram Taluk. The sampling was done for the period of four months from December 2019 to March 2020. The samples were collected from the sampling sites in the early morning. The samples were preserved using 4% formaldehyde and centrifuged. It was then observed under microscope and photographed. The microalgae observed were identified using standard literatures [7-12].

RESULTS AND DISCUSSION

Temple pond have many important functions. The water in the temple pond serves as the vital purpose of recharging the underground water. Ponds are important for environment. During phytoplankton analysis study, the order of distribution of algae was Chlorophyta > Bacillariophyta > Cyanophyta and Euglenophyta. The dominant group of algae reported from the experimental ponds is Cholorophyta. Totally 61 algal taxa were observed under four groups. Dominance of Chlorophyta was also observed in other Indian water bodies by several workers [13-16]. Trivedi and Karode ,2015 [17], reported that higher Chlorophyceae are a large and important group of fresh water algae. The second dominant group studied under the present investigation were Bacillariophyta and totally 24 species were identified. Maximum Bacillariophyceae population during rainy season of the present investigation is also evidenced by the observation of Dubey and Boswal ,2009 [18] in their studies on phytoplankton diversity. Totally 61 phytoplankton species along with 31 genera were recorded in the experimental ponds (P1 and P2), comprising 10 genera with 28 species of green algae, 13 genus with 24 species of diatoms and 5 genera with 6 species of blue green algae, and 3 genera with 3 species of euglenoids were identified. The third dominant group observed from the study area was Cyanophyta. It includes 6 species and the species Microcystis and Oscillatoria were found as common. Phormidium were found as rare form. These algae can tolerate high range of temperature and form the dominant group in the present study [19,20]. Euglenophyceae is represented as a minor group with only three genera like Euglena, Lepocinclis and Trachelomonas were collected during the study period.





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CONCLUSION

From this study it can be concluded that the temple ponds of Murugan Kovil and Sivan Kovil of Radhapuram Taluk of Tirunelveli district have a great diversity with several algal taxa indicating the economically valuable resources which can be used in the field of biotechnology and the phytoplankton encountered in the water body may reflect the ecological status of the freshwater environment. Awareness, planning of proper understanding and management of environmental resources are essential to prevent environmental degradation.

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Table 1: Distribution of Phytoplankton from the Experimental Ponds

Table 1: Distribution of Phytopiankton from the Experimental Ponds							
S.NO	NAME OF THE ALGAE	POND 1	POND 2				
CYANOPHYTA							
1	Aphanothece stagnina (Spr.) A.Braun	+	-				
2	Microcystis aeruginosa Kutz.	+++	++				
3	Microcystis bengalensis Banerji	++	+++				
4	Oscillatoria perornata Skuja	++	+				
5	Phormidium tenue (Men.) Gom.	+	-				
6	Tolypothrix distorta	-	+				
	CHLOROPHYTA						
7	Coelastrum reticulatum (Dang.) Senn.	++	-				
8	Cosmarium bidentatum Turner	+	++				
9	Cosmarium pseudoretusum	-	+				
10	Crucigenia lauterbornii Sch.	+	++				
11	Oedogonium giganteum Kutz.	+++	++				
12	Oedogonium globosum Nordst.	++	-				
13	Oedogonium porrectum Nardst.	+	++				
14	Oedogonium sp	-	+				
15	Pandorina morum (Muller) Bory	+	-				
16	Pediastrum biradiatum	++	++				
17	Pediastrum duplex	+++	+				
18	Pediastrum duplex var reticulatumLagerh.	++	++				
19	Pediastrum simplex	-	+				
20	Pediastrum tetras	+	+				
21	Pediastrum tetras var. tetraodon	++	++				
22	Scenedesmus bijugatusTurp.	+	+++				
23	Scenedesmus bijugatus var. graevenitziiBern.	+++	+				
24	Scenedesmus dimorphus(Turp.) Kuetz.	++	-				
25	Scenedesmus hystrixLag.	-	++				
26	Scenedesmus quadricauda	+	+++				
27	Spirogyra fluviatilis Hilse	++	++				
28	Spirogyra gratiana Trans.	+++	-				
29	Spirogyra sp	+	-				
30	Spirogyra weberiKutz.	-	++				
31	Staurastrum arachneRalfs ex Ralfs	+	+				
32	Staurastrum bieneanum	++	-				
33	Staurastrum leptocladum Nordstedt	-	++				
34	Ulothrix cylindricum Prescott	+	-				
	BACILLARIOPHYTA						
35	Amphora sp	+++	++				
	, 1						





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36				
38 Cyclotella glomerata Bachm. + + 39 Cymbella gracilis (Ehr.) Kutz. ++ +++ 40 Cymbella reinhardtiiGrun. - + 41 Cymbella sp + - 42 Cymbella tumescens A.Cleve ++ + 43 Cymbella tumida (Breb.) Heurck + ++ 44 Cymbella ventricosa var. arcuata Gurn. ++ + 45 Diploneis sp - ++ 46 Fragilaria capucina Desma. + - 47 Fragilaria capucina Desma. + - 47 Fragilaria sp + ++ 48 Gomphonema caminatum ++ ++ 49 Gomphonema clevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula sp + - 53 Navicula sp + - 54	36	Calonesis undulate (Greg.) Kram.	+	-
39 Cymbella gracilis (Ehr.) Kutz. ++ +++ 40 Cymbella reinhardtiiGrun. - + 41 Cymbella sp + - 42 Cymbella tumescens A.Cleve ++ + 43 Cymbella tumida (Breb.) Heurck + ++ 44 Cymbella ventricosa var. arcuata Gurn. ++ + 45 Diploneis sp - ++ 46 Fragilaria capucina Desma. + - 47 Fragilaria capucina Desma. + - 48 Gomphoneia caminatum ++ ++ 49 Gomphonema cevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. ++ + 53 Navicula graciloides Hust. ++ + 54 Pinnularia graciloides Hust. ++ + 55 Pinnularia graciloides Hust. ++ +<	37	Calonies bacillum Grun.	++	+
40 Cymbella reinhardtiiGrun. - + 41 Cymbella sp + - 42 Cymbella tumescens A.Cleve ++ + 43 Cymbella tumida (Breb.) Heurck + ++ 44 Cymbella ventricosa var. arcuata Gurn. ++ + 45 Diploneis sp - ++ 46 Fragilaria capucina Desma. + - 47 Fragilaria sp + + 48 Gomphonema acminatum ++ ++ 49 Gomphonema acminatum ++ ++ 49 Gomphonema clevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. ++ + 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. ++ +	38	Cyclotella glomerata Bachm.	+	+
41 Cymbella sp + - 42 Cymbella tumescens A.Cleve ++ + 43 Cymbella tumida (Breb.) Heurck + ++ 44 Cymbella ventricosa var. arcuata Gurn. ++ + 45 Diploneis sp - ++ 46 Fragilaria capucina Desma. + - 47 Fragilaria sp + ++ 48 Gomphonema acminatum ++ +++ 49 Gomphonema acminatum ++ ++++ 50 Gomphonema clevatoides Gandhi + - 51 Navicula cryptocephalaKutz. ++++++++++++++++++++++++++++++++++++	39	Cymbella gracilis (Ehr.) Kutz.	++	+++
42 Cymbella tumescens A.Cleve ++ + 43 Cymbella tumida (Breb.) Heurck + ++ 44 Cymbella ventricosa var. arcuata Gurn. ++ + 45 Diploneis sp - ++ 46 Fragilaria capucina Desma. + - 47 Fragilaria sp + ++ 48 Gomphonema acminatum ++ +++ 49 Gomphonema acminatum + + +++ 50 Gomphonema clevatoides Gandhi + - - 51 Navicula cryptocephalaKutz. ++ + + 51 Navicula cryptocephalaKutz. ++ + + 52 Navicula radiosa Kutz. +++ + + + 53 Navicula radiosa Kutz. +++ + + + 54 Pinnularia acrosphaeria W.Smith - ++ + + 55 Pinnularia graciloides Hust. +++ + + +	40	Cymbella reinhardtiiGrun.	-	+
43 Cymbella tumida (Breb.) Heurck + ++ 44 Cymbella ventricosa var. arcuata Gurn. ++ + 45 Diploneis sp - ++ 46 Fragilaria capucina Desma. + - 47 Fragilaria sp + ++ 48 Gomphonema acminatum ++ +++ 49 Gomphonema clevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. ++ + 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ 56 Pleurosigma delicatulum W.Smith + + 57 Rhopalodia gibbaEhr. + + 58 Synedra tabulataEhr. + + 59 Euglena pascheri ++ + 60	41	Cymbella sp	+	-
44 Cymbella ventricosa var. arcuata Gurn. ++ + 45 Diploneis sp - ++ 46 Fragilaria capucina Desma. + - 47 Fragilaria sp + ++ 48 Gomphonema acminatum ++ +++ 49 Gomphonema clevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. +++ ++ 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + + 58 Synedra tabulataEhr. + + 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	42	Cymbella tumescens A.Cleve	++	+
45 Diploneis sp - ++ 46 Fragilaria capucina Desma. + - 47 Fragilaria sp + ++ 48 Gomphonema acminatum ++ +++ 49 Gomphonema clevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. +++ ++ 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	43	Cymbella tumida (Breb.) Heurck	+	++
46 Fragilaria capucina Desma. + - 47 Fragilaria sp + ++ 48 Gomphonema acminatum ++ +++ 49 Gomphonema clevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. +++ ++ 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	44	Cymbella ventricosa var. arcuata Gurn.	++	+
47 Fragilaria sp + ++ 48 Gomphonema acminatum ++ +++ 49 Gomphonema clevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. +++ ++ 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	45	Diploneis sp	-	++
48 Gomphonema acminatum ++ +++ 49 Gomphonema clevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. +++ ++ 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	46	Fragilaria capucina Desma.	+	-
49 Gomphonema clevatoides Gandhi + - 50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. +++ ++ 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + + 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	47	Fragilaria sp	+	++
50 Gomphonema cristatum Ralfs - ++ 51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. +++ ++ 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	48	Gomphonema acminatum	++	+++
51 Navicula cryptocephalaKutz. ++ + 52 Navicula radiosa Kutz. +++ ++ 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	49	Gomphonema clevatoides Gandhi	+	-
52 Navicula radiosa Kutz. +++ ++ 53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	50	Gomphonema cristatum Ralfs	-	++
53 Navicula sp + - 54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	51	Navicula cryptocephalaKutz.	++	+
54 Pinnularia acrosphaeria W.Smith - ++ 55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	52	Navicula radiosa Kutz.	+++	++
55 Pinnularia graciloides Hust. +++ ++ 56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	53	Navicula sp	+	-
56 Pleurosigma delicatulum W.Smith ++ ++ 57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	54	Pinnularia acrosphaeria W.Smith	-	++
57 Rhopalodia gibbaEhr. + ++ 58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	55	Pinnularia graciloides Hust.	+++	++
58 Synedra tabulataEhr. + + EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	56	Pleurosigma delicatulum W.Smith	++	++
EUGLENOPHYTA 59 Euglena pascheri ++ + 60 Lepocinclis sp + -	57	Rhopalodia gibbaEhr.	+	++
59 Euglena pascheri ++ + 60 Lepocinclis sp + -	58	Synedra tabulataEhr.	+	+
60 Lepocinclis sp + -		EUGLENOPHYTA		
	59	Euglena pascheri	++	+
61 Trachelomonas intermedia Defl. + ++	60	Lepocinclis sp	+	-
	61	Trachelomonas intermedia Defl.	+	++

+++ = Abundant; ++ = Dominant; + = Rare; -= Absent









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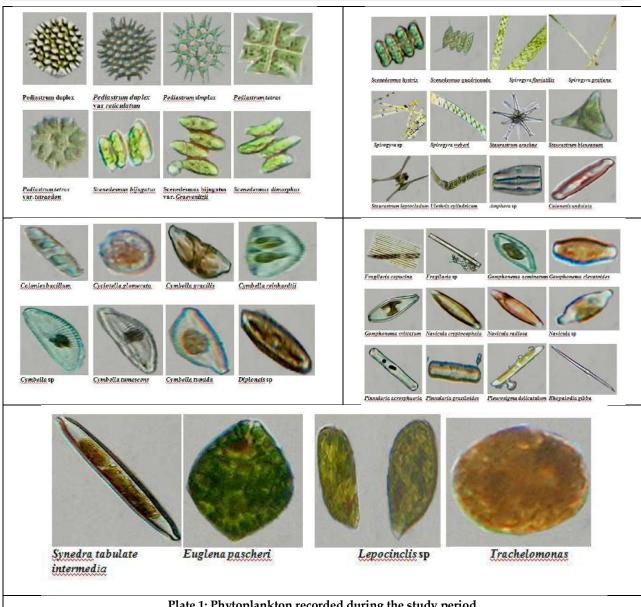


Plate 1: Phytoplankton recorded during the study period





RESEARCH ARTICLE

Independent Restrained k Rainbow Domination Number for Degree **Splitting Graphs**

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ABSTRACT

For graph G, The *Degree Splitting Graph DS(G)* is obtained from G, with $V(G) = S_1 \cup S_2 \cup S_3 \cup ... \cup S_n \cup S_$ $S_t \cup T$ where each S_i is a set with at least two vertices having same degree and $T = V \cup \bigcup_{i=1}^t (S_i)$ by adding vertices $w_1, w_2, w_3, ..., w_t$ and joining each w_i to each vertex of S_i ($1 \le j \le t$). In this paper, we obtain the minimum Independent Restrained k Rainbow Domination number for some degree splitting graphs of path, star, cycle, wheel, flower, complete graphs etc.

Keywords: Degree Split graphs, Domination, Independent, Rainbow, Restrained, weight.

INTRODUCTION

The Rainbow domination in graphs was introduced by Bresaret al. [1]. And further it was studied by several authors. Zehui shao et al. [6] introduces Independent t- Rainbow domination. AbdollahzadehAhangar et al. [2] finds the Rainbow restrained domination number for some graphs. Shailaja Shankar Shirkol, Pavithra P Kumbargourda, et al. [5] discussed Roman and k- Rainbow Domination number for Degree Splitting Graph. Already we have studied the Independent Restrained k Rainbow Domination number for some standard graphs and finds bounds for some





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special graphs [3,4]. In this paper we continue the study and investigate Independent Restrained k Rainbow domination number for degree splitting graphs of path, cycle, complete, star, wheel and for some special graphs.

PRELIMINARIES

Definition: 2.1

[1] Let G be a graph. let $f: V(G) \to P$ [1,2,3,...,k] assigns to each vertex by subset of colors {1,2,3,...k} that is if the vertex $u \in V(G)$ such that $f(u) = \emptyset$ we have the open neighborhood of u should contains all the k colors, Then the function f is called the *k Rainbow Dominating Function (KRDF)* of G.

Definition: 2.2

[3] A k Rainbow dominating function is said to be Independent Restrained k Rainbow Dominating Function (IRkRDF) if, The Induced sub graph by the vertices with labeled \emptyset has no isolated vertices and The vertices which are assigned with subset of k colors is Independent The minimum weight of G, is Independent Restrained k Rainbow Domination number and is denoted by $\gamma_{trkr}(G)$. The weight $w(f) = \sum_{v \in V(G)} |f(v)|$.

MAIN RESULTS

Theorem:3.1

Let G be any regular graph then $\gamma_{irkr}(DS(G)) = k$

Proof

Let G be a regular graph with $v_i \in V(G)$. Then DS(G) = G + K_1 . Then V(DS(G)) = $S_1 \cup w_1$ where $S_1 = V(G)$ Hence $w_1 \in V(k_1)$ becomes a full degree vertex.

Define $f: V(DS[G]) \rightarrow P[1, 2, ..., k]$ by

Define
$$f:V(DS[G]) \rightarrow P[1,2,...,k]$$

$$f(x) = \begin{cases} \{1,2,3,...,k\} & if & x = w_1 \\ \emptyset & otherwise \end{cases}$$

The vertices with empty label satisfies the Rainbow domination condition $\bigcup_{w_1 \in N[v]} f(u) = \{1,2,...,k\}$. since $w_1 \in N[v]$ Further, the vertex w_1 is the only vertex which is assigned non-empty labels and the set of vertices $\{v_1, v_2, v_3, ... v_n\}$ which are assigned empty has no isolated vertices. Since G is regular.

Hence, f is a minimum IRkDF.

Illustration: 3.2

Let G be a 4- regular graph with 5 vertices.

Letf: $V(DS(G)) \rightarrow \mathcal{P}[1,2,3,4]$

Assign $f(w_1) = \{1,2,3,4\}$ and \emptyset to the remaining vertices.

Then $w(f) = |f(w_1)| = 4$.

$$\therefore \ \gamma_{ir4r}(G) = \ 4$$

Corollary: 3.3

Independent Restrained k rainbow domination number for Degree splitting graph of Complete graph, cycle graph, complete bipartite graph $K_{m,n}$ if m = n is equal to k.

Illustration:3.4

Let $f: V(DS(C_6)) \rightarrow \mathcal{P}[1,2,3]$

Assign $f(w_1) = \{1,2,3\}$ and \emptyset to the remaining vertices.

Then w(f) =
$$|f(w_1)| = 3$$
. $\therefore \gamma_{ir3r}(DS(C_6)) = 3$





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Theorem: 3.5

 $\gamma_{irkr}(DS(P_n)) = 2k \text{ for } n \ge 4.$

Proof

Let $V(P_n) = \{v_1, v_2, ..., v_n\}$. Then $V(DS(P_n)) = S_1 \cup w_1 \cup S_2 \cup w_2$ where $S_1 = \{v_2, v_3, ..., v_{n-1}\}S_2 = \{v_1, v_n\}$. The vertex w_1 is adjacent to S_1 and w_2 is adjacent to S_2

Define
$$f:V(DS[P_n]) \rightarrow P[1,2,...,k]$$
 by
$$f(x) = \begin{cases} \{1,2,3,...,k\} & if \quad x = w_1 \text{ and } w_2 \\ \emptyset & otherwise \end{cases}$$

Clearly, every vertex with empty label satisfies the rainbow domination condition $\bigcup_{v_1 \in N[w_1]} f(v_1) = \{1,2,3,...,k\}$

Further, The set of vertices $\{v_1, v_2, v_3, ... v_n\}$ which are assigned empty has no isolated vertices and the vertices $w_1, w_2, w_3, ... v_n\}$ which are labeled non-empty are maximal independent set. f gives the minimum weight.

Hence, f is a minimum IRkRDF.

Illustration:3.6

Let $f: V(DS(P_7)) \rightarrow \mathcal{P}[1,2,3,4,5]$

Assign $f(w_1) = f(w_2) = \{1,2,3,4,5\}$ and assign \emptyset to the remaining vertices.

Then
$$w(f) = |f(w_1)| + |f(w_2)| = 10$$

$$\therefore \gamma_{ir5r}(DS(P_7)) = 10$$

Theorem:3.7

Let W_n be the wheel graph with n vertices then $\gamma_{irkr}(DS(W_n)) = k$ for $n \ge 4$.

Proof

Let v_1, v_2 , ... , v_{n-1} be the apex vertices. Let v_0 be the central vertex.

Then $V(DS(W_n)) = S_1 \cup w_1 \cup v_0$ where $S_1 = \{v_1, v_1, \dots, v_{n-1}\}$ and the vertex w_1 is adjacent to S_1 .

Define
$$f: V(DS[W_n]) \to P[1,2,...,k]$$
 by $f(x) = \begin{cases} \{1\} & \text{if } x = v_0 \\ \{2,3,...,k\} & \text{if } x = w_1 \end{cases}$

Clearly, the vertex with label empty satisfies the Rainbow domination condition $\bigcup_{v_i} f(v_i) = \{1, 2, ..., k\}$

Further, The set of vertices $\{v_1, v_2, v_3, ... v_{n-1}\}$ which are assigned empty has no isolated vertices and the vertex $w_1 \& v_0$ which are assigned non-empty labels are maximal independent.f gives the minimum weight.

Hence, f is a minimum IRkRDF.

Illustration:3.8

Let $f: V(DS(W_7)) \to \mathcal{P}[1,2,3,4,5,6]$

Assign $f(w_1) = \{2,3,4,5,6\}$; $f(v_0) = \{1\}$ and \emptyset to the remaining vertices.

Then w(f) =
$$|f(w_1)| + |f(v_0)| = 5$$

 $\therefore \gamma_{ir6r}(DS(W_7)) = 7$

Theorem:3.9

$$\gamma_{irkr}\left(DS(K_{m,n})\right) = 2k \text{ for m < n \& m > n}$$





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Proof

Let $K_{m,n}$ be the complete bipartite graph. Let $V_1 = \{u_i\}$; i = 1 to $m\&V_2 = \{v_j\}$; j = 1 to n be the partition set of $K_{m,n}$. Then $V(DS(K_{m,n})) = S_1 \cup w_1 \cup S_2 \cup w_2$ where $S_1 = V_1$; $S_2 = V_2$; and the vertex w_1 is adjacent to S_1 and w_2 is adjacent to S_2 . Define $f: V(S[K_{m,n}]) \rightarrow P[1,2,...,k]$ by

Define
$$f: V(S[K_{m,n}]) \to P[1,2,...,k]$$
 by
$$f(x) = \begin{cases} \{1,2,...,k\} & \text{if } x = w_1 \text{ and } w_2 \\ \emptyset & \text{otherwise} \end{cases}$$

The vertices with label empty satisfy the k rainbow domination condition.

Further, the set of vertices $\{V_1, V_2\}$ which are assigned empty has no isolated vertices. Since the vertices $w_1 \& w_2$ which are assigned non-empty labels is the maximal independent set, f gives the minimum weight.

Hence, f is a minimum IRkRDF.

Illustration:3.10

Let $f: V(DS(K_{4,3})) \rightarrow \mathcal{P}[1,2,3,4,5]$

Assign $f(w_1) = \{1,2,3,4,5\}$; $f(w_2) = \{1,2,3,4,5\}$ and \emptyset to the remaining vertices.

Then $w(f) = |f(w_1)| + |f(w_2)| = 10$

$$\therefore \gamma_{ir5r} \left(DS(K_{4,3}) \right) = 10$$

Theorem:3.11

$$\gamma_{irkr}(DS(P_n + K_1)) = k + 1 \text{ for } n \ge 4$$

Proof

Let $v_i \in V(P_n)$; i = 1 to n. Let u be the new vertex.

Then $V(DS(P_n + K_1)) = S_1 \cup w_1 \cup S_2 \cup w_2 \cup u$ where $S_1 = \{v_1, v_n\}$; $S_2 = \{v_2, v_3, ..., v_{n-1}\}$ and the vertex w_1 is adjacent to S_1 and w_2 is adjacent to S_2

Define
$$f: V(DS[P_n + K_1]) \to P[1, 2, ..., k]$$
 by
$$f(x) = \begin{cases} \{2, 3, ..., k\} & \text{if } x = u \\ \{1\} & x = w_1 \text{ and } w_2 \end{cases}$$

Ø otherwise

Obviously, the vertices u_i ; i =1 to n with labelled \emptyset satisfies the k Rainbow Domination condition.

Further, the set of vertices $\{v_i\}$ where i=1 to n which are assigned empty has no isolated vertices. Since the vertices w_1 , w_2 , u which are assigned non-empty labels is the maximal independent set. Also, no color is repeated at every vertex assigned \emptyset . Hence f gives the minimum weight.

Hence f is a minimum IRkRDF.

Further, w(f) =
$$\sum_{i=1}^{m} (|f(w_i)| + |f(v_i)|) + |f(u)|$$

Therefore $\gamma_{irkr} (DS(P_n + K_1)) = k + 1$

Illustration: 3.12

Let
$$f: V(DS(P_7 + K_1)) \to \mathcal{P}[1,2,3,4,5]$$

Assign $f(v) = \{2,3,4,5\}$ and $f(v_2) = f(v_3) = \{1\}$ and \emptyset to the remaining vertices.
Then $w(f) = |f(w_1)| + |f(w_2)| + |f(v)| = 6$

$$\therefore \gamma_{ir5r}(DS(P_7 + K_1)) = 6$$

Theorem:3.13

$$\gamma_{irkr}(DS(H_m)) = 2k \text{ for } n \ge 4$$





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Proof

Let H_m be the helm graph.Let v_t ; t=1 to m-1 be the rim vertex. Let u_t ; t=1 to m-1 where each v_t is adjacent to u_t ; $1 \le t \le m-1$.Let v be the apex vertex .Then $V(DS(H_m)) = S_1 \cup w_1 \cup S_2 \cup w_2 \cup v$ where $S_1 = \{v_1, v_2, v_3, \dots v_{m-1}\}$; $S_2 = \{u_1, u_2, \dots u_{m-1}\}$ and the vertex w_1 is adjacent to S_1 and w_2 is adjacent to S_2

Define f: V (DS (H_m)) $\rightarrow \mathcal{P}[1,2,...,k]$ by

$$f(x) = \begin{cases} \{2,3,...,k\} & if \quad x = w_1 \\ \{1,2,3,...,k\} & if \quad x = w_2 \\ \{1\} & if \quad x = v \\ \emptyset & otherwise \end{cases}$$

Clearly, vertex with empty label satisfies the Rainbow domination condition.

Further, the set of vertices $\{u_t, v_t\}$ where t= 1 to n-1 which are assigned empty has no isolated vertices. Since the vertices w_1 , w_2 , v which are assigned non-empty labelsis the maximal independent set, f gives the minimum weight.

Hence, f is an IRkRDF.

$$\dot{\cdot} w(f) = \sum_{t=1}^{n-1} \left[|f(u_t)| + |f(v_t)| \right] + |f(w_1)| + |f(w_2)| + |f(v)|$$

$$\gamma_{irkr} \left(DS(H_n) \right) = 2k$$

Illustration:3.14

Let
$$f: V(DS(H_7)) \to P[1,2,3]$$

Assign $f(w_2) = \{1,2,3\}$; $f(w_1) = \{2,3\}$; $f(v) = \{1\}$ and \emptyset to the remaining vertices.
Then $w(f) = |f(w_1)| + |f(w_2)| + |f(v)| = 6$
 $\therefore \gamma_{ir3r}(DS(H_7)) = 6$

Theorem: 3.15

$$\gamma_{irkr}(DS(FL_n)) = k + 1 \text{ for } n \ge 4$$

Proof

Let FL_n be the flower graph obtained from H_n . Let $V(FL_n) = \{v_1, v_2, v_3, \dots v_{n-1}, u_1, u_2, \dots u_{n-1}, v\}$ where each u_t is adjacent to v_t and v where $1 \le t \le n-1$. Then $V(DS(FL_n)) = S_1 \cup w_1 \cup S_2 \cup w_2 \cup v$ where $S_1 = \{v_1, v_2, v_3, \dots v_{n-1}\}$; $S_2 = \{u_1, u_2, \dots u_{n-1}\}$ and the vertex w_1 is adjacent to S_1 and w_2 is adjacent to S_2

$$\mathbf{f}(\mathbf{x}) = \begin{cases} \{k\} & if \quad x = w_1 \ and \ w_2 \\ \{1, 2, \dots, k-1\} & if \quad x = v \\ \emptyset & otherwise \end{cases}$$

Clearly, every vertex with label empty satisfies the k rainbow domination condition.

Further the set of vertices $\{u_t, v_t\}$ where t= 1 to n-1 which are assigned empty has no isolated vertices. Since the vertices w_1 , w_2 , v which are assigned non-empty labels is the maximal independent set, f gives the minimum weight. Hence, f is a minimum IRkRDF.

Corollary: 3.16

For the degree splitting graph of $K_{1,n}$, Independent Restrained k Rainbow dominating function does not exist. Since it does not satisfy Independent and Restrained condition.

Remark:1.17

For any connected graph G, $\gamma_{irkr}(DS(G)) \leq |w_i \cup T|$

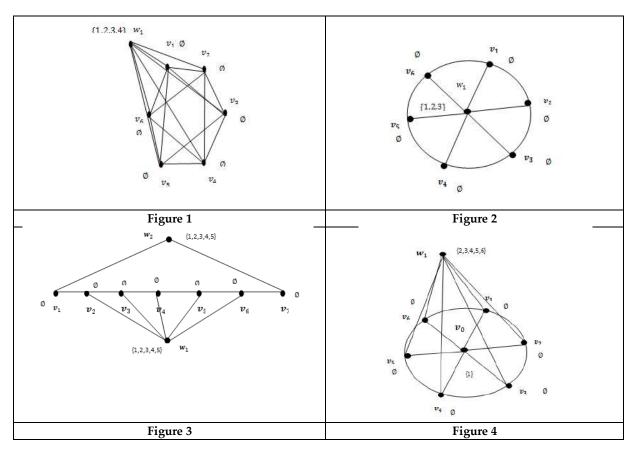




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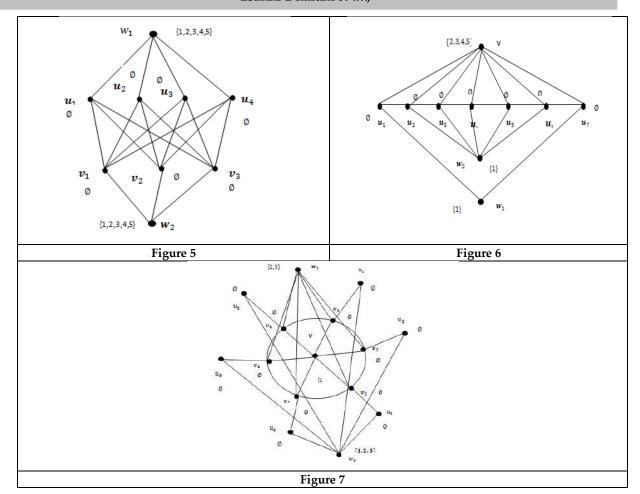
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RESEARCH ARTICLE

Effectiveness of Early Physiotherapy Assisted Mobilization and Flutter Device on Pulmonary Functions and Quality of Life in Subjects with Open Abdominal Surgery - A Comparative Study

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ABSTRACT

To compare the effects of early mobilization along with conventional chest Physiotherapy versus flutter along with conventional chest Physiotherapy on pulmonary functions and quality of life in subjects with open abdominal surgery. Comparative study conducted on patients undergoing open abdominal surgery. 60 subjects randomly assigned to Group A (n=30) received early Physiotherapy assisted mobilization along with conventional CPT and Group B (n=30) received flutter along with conventional CPT. Intervention was given twice daily for 1st two POD followed by once daily till 7th POD. Outcome measures FVC, FEV1, FEV1/FVC and SF-36were assessed pre-operatively and on 7th POD. Pre measures of mean values for Group A for FVC, FEV1, FEV1/FVC were 2.44, 1.86, 73.44and for Group B were 2.11, 1.63, 79.95. Post measures for Group A were 2.55, 2.04, 88.98 and for Group B were 2.19, 1.69, 82.44 respectively. P-value for FEV1/FVC for Group A was 0.000. Pre measures of PF, RL, BP, SF, GMH, RLDEP, VEF, GHP for Group A were 49.25, 31.66, 19.08, 30.83, 25.6, 27.77, 24.83, 28 and for Group B were 57.41, 38.33, 33.91, 38.33, 34.93, 24.44, 31.83, 38.83. Post measures for Group A were 71.85, 67.5, 68.91, 76.25, 75.2, 75.55, 70.83, 65.33and for Group B were 77.03, 75.83, 73, 78.33, 75.33, 80, 76.66, 69.33respectively. P-value for pre-post measures was found out to be <0.05 in both groups. Mean scores for Group A for FVC, FEV1, FEV1/FVC were 0.1, 0.17, 15.53 and for Group B were 0.09, 0.05, 2.48 respectively. P-value for FEV1/FVC was 0.003. Mean scores for PF, RL, BP, SF, GMH, RLDEP, VEF, GHP for Group A were 22.59, 35.83, 49.83, 45.41, 49.60, 47.78, 46.00, 37.33 and for Group B were 19.62, 37.50, 39.08, 40.00, 40.40, 55.55, 44.83, 30.50 respectively. P-value for BP (p=0.001), SF (p=0.043), and GMH (p=0.012). The present study concluded that statistically both the treatment protocols were effective. But





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implementation of early mobilization along with conventional CPT was more effective in improving pulmonary functions and QOL following open abdominal surgery.

Keywords: Abdominal surgery, Early mobilization, Quality of life, Pulmonary function, Chest Physiotherapy

INTRODUCTION

Following major abdominal surgeries, the vital capacity (VC) reduces by 50% to 60% ,FRC by 30% for few days to week. [1] PPCs account for 4 to 22% in abdominal surgery and 17 to 88% in upper abdominal surgery. [2] This deterioration results in "restrictive lung disorders" that ultimately lead to respiratory insufficiency, reduced diaphragmatic movement and atelectas is, diminished vital and inspiratory capacities. [3] It is associated with significant loss in functional capacity, decline in physical and mental health status, impairment in HRQOL, patient outcomes, and lower survival. [4][5] "Early mobilization" significantly improves reduction in FRC, improves minute ventilation, tidal volume, FVC, maximum voluntary ventilation, gas exchange, ventilation perfusion distribution, arterial oxygenation, and decreases PaCO2 levels. [6][7][8] Flutter is one such self-regulated oscillating positive expiratory pressure (OPEP) device that combines- PEP and oscillations. [9][10][11] The oscillations have a "thixotropic effect" that improves secretions' movement from the periphery or distal to the central airways, which improves pulmonary functions and oxygenation. [11][12][13] The aim of this study was to compare the effects of early mobilization along with conventional chest Physiotherapy versus flutter along with conventional chest Physiotherapy on pulmonary functions and quality of life in subjects with open abdominal surgery.

MATERIALS AND METHODS

All the subjects undergoing open abdominal surgery were recruited from Parul Sevashram Hospital, Vadodara, Gujarat. Following an initial screening, 60 subjects both males and females aged between 44-60 years [14][15], having 40 beats per minute < heart rate < 130 beats per minute [16], 90 mmHg < systolic arterial pressure < 200 mmHg [16], 5 breaths per minute < respiratory rate \leq 24 breaths per minute [16], peripheral oxygen saturation \geq 90% [16], surgery under G.A [16], subjects with preoperative ambulation who were independent [17], willingness to participate [18], sufficient level of consciousness that allows correct understanding and execution of commands [8] were included. Subjects who had undergone emergency open abdominal surgery [19], any neurological or cardiovascular conditions [8], past history of pulmonary disorder [19], hemodynamic instability [8] and having severe pain (>8 on VAS) [8] were excluded. Ethical approval was obtained from Parul University Institutional Ethics Committee for Human Research (PUIECHR/PIMSR/00/081734/4505). The trial was registered prospectively at the Clinical Trials Registry of India (CTRI/2023/01/048797).

Outcome measures

Pulmonary Functions-FVC, FEV1 and FEV1/FVC

Instructions-The subjects were instructed to take a comfortable seated position. In order to prevent additional air from escaping from the mouth, subjects were instructed to tightly seal the mouthpiece between two lips. Then instructed to inhale deeply and exhale through the mouthpiece as hard as possible for a number of seconds. The subjects were not allowed to breathe through their nose. This procedure was repeated for 2 to 3 repetitions.

Quality of Life Questionnaire-SF-36

Instructions- The scores for each single SF-36 item are coded, aggregated, and converted into a scale ranging from 0 to 100, where 0 is "the worst" and 100 represents "the best health status". In order to determine the subjects' response to the question, each question was scored by the subjects based on how much they felt about their general health





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status had changed compared to the previous year. Using scales with 2 "yes or no" to 6 categories, responses were recorded as "all of the time", "most of the time", "a good bit of time", "some of the time", "a little of time", "none of the time".

PROCEDURE

Total 60 subjects both males and females were recruited from Parul Sevashram Hospital. Study sample included subjects undergoing open abdominal surgery. Subjects fulfilling the inclusion criteria were selected and assessed preoperatively. A written and fully informed consent was taken from all the subjects, and their privacy and confidentiality was maintained. Before starting the intervention, a pre-test was conducted. Evaluation of outcome measures was done through PFT and QOL scale-SF-36. Group A received early Physiotherapy assisted early mobilization along with conventional CPT and Group B received flutter along with conventional CPT. Intervention was given twice daily for 1st 2 POD followed by once daily till 7th POD. After the completion of the intervention i.e., on 7th POD, the outcome measures were re-examined and the comparison of pre-posttest scores and between-group analysis was carried out.

Intervention

Subjects were randomly assigned in 2 groups using chit method.

Group A: Received early Physiotherapy assisted mobilization along with conventional chest Physiotherapy.

Group B: Received flutter along with conventional chest Physiotherapy.

GROUP A: Early mobilization program

- > Sit on bed side
- Sit at the edge of bed or sit on chair
- ➤ Walk 5 meter with assistance
- Walk 15 meter with assistance
- ➤ Walk 30 meter with assistance
- Walk 30 meter without assistance
- ✓ Subjects were mobilized on 1st POD (Onset <48 hour post-operatively).

Assessment of the subject's vital signs and state of consciousness was done in supine lying, then elevation of the headend was performed, only if no abnormalities were seen. [17] Then the subjects were transferred to sitting on the edge of the bed with their lower extremities in hanging (sitting was defined as if subjects able to maintain this position for more than 5 minutes at least on a day). [17] Then, the subjects were taken to standing position and ambulation started with 5 meters then progressed to 15 meters with the assistance from Physiotherapist, if they were physiologically stable and showed no indicators of abnormal vital signs like orthostatic hypotension, tachycardia or symptoms like vomiting or nausea. [18][17] If unsafe mobilization symptoms prevented mobilization, the subjects were returned to their bed to rest and a new mobilization attempt was attempted after a 30minutes interval. [20] Gradually, subjects were made to walk 30 meters with assistance from Physiotherapist and finally ambulation was advanced to walk 30 meters without assistance. [18] Minimal targeted ambulation following intervention was 1 lap in corridor (approximately 200 meters) independently and distance was increased in accordance to subjects' tolerance. [21]

GROUP-B: Flutter treatment program

Subjects were instructed to sit comfortably with neck slightly extended to open the airways and hold the flutter device in a horizontal and tilted upward position to achieve the maximum oscillatory effect. [9] Then instructed to place the device in their mouth, and asked to inhale slowly and deeply (but not completely) through the nose followed with a breath hold of 3 to 5 seconds followed by breath out through the flutter device at a slightly faster rate than usual. [9] Once, 4 to 8 of these breaths have been completed, subjects were asked to take a deep breath and hold it at full inspiration followed by a forceful expiration through the flutter device. [9] This facilitated expectoration,





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which was then followed by a break for breathing control, then a cough or huff was performed as per the subjects' preferences, and the procedure continued for 10 to 15 minutes. [9]

✓ Subjects were mobilized according to their will.

STATISTICAL ANALYSIS

In order to analyse the results, IBM SPSS version 27 was used. Normality was checked by using Shapiro Wilk Test. The data analysed did not followed the normal distribution therefore, the Wilcoxon-Signed-Rank test was used for intra group pre-post-analysis and the Mann-Whitney U test was utilized for between-group analysis. The alpha level of 0.05 was kept for analysis of data. Micro soft word and excel version 2019 were used to create graphs and tables.

RESULTS

In total, 70 subjects were screened for the study. Out of which 10 subjects did not match the inclusion criteria; data of 60 subjects were included for the statistical analysis. Within-group analysis for PFT showed that there was clinically more improvement seen in FEV1/FVC% in Group A with (p=0.000) which is considered statistically significant (p<0.05). Within-group analysis of all eight health domains of SF-36 (PF, RL, BP, SF, GMH, RLDEP, VEF, GHP) had statistically significant improvement with (p<0.05) in both Group A and Group B. The between-group analysis showed that FEV1/FVC% was statistically significant (p=0.003) with (p<0.05). The between-group analysis of SF-36 found that there was statistically significant value following domains: BP (p=0.001), SF (p=0.043), and GHM (p=0.012). There was clinically improvement seen in following domains PF, RL, RLDEP, VEF, and GHP despite no statistical changes (p>0.05). Therefore, present study found that statistically both the treatment were effective and clinically improvement was seen in both the groups after implementation of the interventions.

DISCUSSION

The current study evaluated whether Physiotherapy assisted early mobilization along with conventional CPT or the use of flutter device along with conventional CPT which is more effective in improving pulmonary functions and QOL following open abdominal surgery. In the fast-track approach, ERAS and other perioperative care guidelines strongly advise forcing "Early Mobilization" (i.e., starting various out-of-bed activities from the day after surgery). [7][21]It also recommends that the patient should stay out of bed for two hours on the 1st POD and six hours per day until discharge on the subsequent days (Gustafsson et al., 2019). [22] The findings of the present study is supported by Sana Bashir et al. which explained that positional change after abdominal surgeries from supine to sitting significantly improves gas exchange, ventilation perfusion distribution, increase in minute ventilation, decrease in PCO2 levels, improves tissue oxygen absorption levels and concluded that early mobilization along with CPT helps in preventing PPCs, improves respiratory outcomes and improves QOL. [8] It is also reported that the daily frequency, duration of daily mobilization involving upright position and walking more 5 meters on the same day of surgery improves pulmonary functions. [18] According to research, "setting-goals" formobilization process has a motivating effect on patient's outcomes. According to Fadime Koyuncu et al., patients in the intervention group were more likely to achieve the established/targeted mobilization goals than those in the control group. [22] According to Hu et al. (2019), it is yet unknown if patients who adhere to a certain "structured" mobilization protocol will have improved "physical recovery" than those who were mobilized according to their own will. [22] According to a ROL, it is unknown how often patients require mobilization after abdominal surgery (Castelino et all., 2016). [22] Thus, to stimulate a speedy recovery to physical fitness and restore normal pulmonary function, "a well-structured, graduated exercise programme" that challenges the individual patient's cardiopulmonary system must be implemented. [23] Inprior cohort study, involving 76 participants, Aljabri and collaborators discovered substantial decline in the SF-36 PCS component 5 weeks following open abdominal surgery. [24]. Similar result was observed after gastric and colorectal surgery at one month and after liver resection surgery [24]. In a study, the PCS component had a greater clinically relevant decrease (40%) than the MCS component (20%) [24]. This decline in physical QOL is related to the





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continuing healing process following a "Post-Operative Acute Systemic Inflammatory Response Syndrome" after major surgery, which also includes the sickness behaviour, or an incomplete post-operative rehabilitation, developing post-operative complications, and experiencing significant discomfort. [24] The patient's state of mind following surgery may be a result of feeling of relief, "being cured" or from the surgical procedure that he/she have undergone, which transitions over time as they return to their baseline functional level.[24] So, if any future study is directed to analyse the effect of Early Mobilization on FEV1/FVC, then Early Mobilization along with conventional CPT can be implemented. HRQOL questionnaire SF-36 scores can be used as a part of outcome assessment to predict the degree of change in QOL following major open abdominal surgery.

CONCLUSION

The present study concluded that statistically both the treatment protocols were effective. But implementation of Early Mobilization along with conventional chest Physiotherapy was more effective in improving pulmonary functions and quality of life in subjects undergoing open abdominal surgery.

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Conflicts of interest: None

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Table: 1- Age Distribution of both Group

AGE IN YEARS	GROUP A	GROUP B	TOTAL
44-50	10	14	24
51-55	9	7	16
56-60	11	9	20
Total	30	30	60

WITHIN GROUP ANALYSIS

Table: 2 -Pre-Post Comparison of PFT for Group A

GROUP A	Mean	±SD	Z- value	P-value	Test			
PRE-FVC	2.44	0.78	1 72	0.085				
POST-FVC	2.55	0.6	-1.72	0.063				
PRE-FEV1	1.86	0.78	-1.761	0.078	Wilcoxon Signed Rank Test			
POST-FEV1	2.04	0.77	-1./01					
PRE-FEV1/FVC	73.44	13.69	-4.13					
POST-FEV1/FVC	88.98	7.52	-4.13	0.000				

Table: 3-Pre-PostComparison of PFT for Group B

GROUP B	Mean	±SD	Z- value	P-value	Test			
PRE-FVC	2.11	0.81	-0.628	0.53				
POST-FVC	2.19	0.79	-0.626	0.55				
PRE-FEV1	1.63	0.60	-0.772	0.44	Wilcoxon Signed Rank Test			
POST-FEV1	1.69	0.49	-0.772					
PRE- FEV1/FVC	79.95	8.47	1 170					
POST- FEV1/FVC	82.44	3.68	-1.178	0.239				

Table: 4- Pre-Post Comparison of SF-36 for Group A

Table. 4-11e-10st Companison of 51-50 for Group A											
GROUP A	MEAN	±SD	Z-VALUE	P-VALUE	TEST						
PRE-PF	49.25	25.79	-4.342	0.000							
POST-PF	71.85	15.36	-4.342	0.000							
PRE-RL	31.66	30.74	-4.081	0.000							
POST-RL	67.5	22.88	-4.001	0.000	Wilesyon Comed Donk Tost						
PRE-BP	19.08	11.75	-4.829	0.000							
POST-BP	68.91	11.31	-4.029	0.000	Wilcoxon Signed Rank Test						
PRE-SF	30.833	13.42	-4.68	0.000							
POST-SF	76.25	11.99	-4.68	0.000							
PRE-GMH	25.6	12	-4.791	0.000							
POST- GMH	75.2	7.67	-4./91	0.000							





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PRE- RLDEP	27.77	30.42	-4.57	0.000		0.000	
POST- RLDEP	75.55	19.44	-4.57	-4.57	0.000		
PRE-VEF	24.83	9.95	4.704	-4.794	0.000		
POST-VEF	70.83	11.6	-4.794	0.000			
PRE-GHP	28	12.14	-4.797	0.000			
POST-GHP	65.33	8.8	-4./9/	0.000			

Table: 5- Pre-Post Comparison of SF-36 for Group B

Table: 5- Tie-1 ost Companison of 51-30 for Group B										
GROUP B	MEAN	±SD	Z-VALUE	<i>P</i> -VALUE	TEST					
PRE-PF	57.41	20.64	-4.629	0.000						
POST-PF	77.03	13.74	-4.629	0.000						
PRE-RL	38.33	25.2	-4.541	0.000						
POST-RL	75.83	19.12	-4.341	0.000						
PRE-BP	33.91	9.13	-5.002	0.000						
POST-BP	73	9.5	-5.002	0.000						
PRE-SF	38.33	12.25	-4.881	0.000	0.000 Wilcoxon Signed Rank Test					
POST-SF	78.33	5.62	-4.001	0.000						
PRE-GMH	34.93	8.46	-4.804	0.000						
POST- GMH	75.33	6.97	-4.004	0.000						
PRE- RLDEP	24.44	21.32	-4.826	0.000						
POST- RLDEP	80	22.48	-4.020	0.000						
PRE-VEF	31.83	6.49	-4.838	0.000						
POST-VEF	76.66	5.31	-4.030	0.000						
PRE-GHP	38.83	7.73	4.800	0.000						
POST-GHP	69.33	8.38	-4.809	0.000						

BETWEEN GROUP ANALYSIS

Table: 6- Between Group Analysis for Group A and B of PFT

	GROUP	MEAN	±SD	Z- VALUE	P- VALUE	TEST
FVC	A	0.1	0.74	-0.274	0.784	
rvC	В	0.09	0.91	-0.274	0.764	Mann-Whitney test
FEV1	A	0.17	0.59	-0.888	0.375	
FEVI	В	0.05	0.62	-0.000	0.373	
FEV1/FVC	A	15.53	17.96	-2.99	0.003	
FEV1/FVC	В	2.48	7.39	-2.99	0.003	

Table: 7- Between Group Analysis for Group A and B of SF-36

	GROUP	MEAN	±SD	Z- VALUE	P- VALUE	TEST
PF	A	22.59	16.75	-0.963	0.002	
ГГ	В	19.62	13.11	-0.963	0.335	
RL	A	35.83	30.57	-0.353	0.353 0.734	
KL	В	37.50	24.34	-0.535	0.724	Mana Milana took
BP	A	49.83	12.71	-3.326		Mann-Whitney test
DI	В	39.08	12.39	-3.326	0.001	
SF	A	45.41	17.82	-2.024	0.043	
ЭГ	В	40.00	10.06	-2.024	0.043	





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GMH	A	49.60	15.13	2 502	0.012	
GMH	В	40.40	11.37	-2.503	0.012	
RLDEP	A	47.78	25.79	-0.738	0.461	
KLDEI	В	55.55	25.26	-0.736	0.461	
VEF	A	46.00	17.39	-0.613	0.540	
VEF	В	44.83	8.45	-0.613	0.340	
GHP	A	37.33	14.00	-1.714	0.087	
GH	В	30.50	10.69	-1./14	0.067	





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RESEARCH ARTICLE

A Topological Control Algorithm for Decision-Making in Complex **Material Systems**

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ABSTRACT

The Pawlak theory of rough sets limits the application due to the conditions of equivalence relation. Thus we need the binary relations to generalize and expand the areas of Pawlak application. This is done by introducing the concept of initial neighborhood and recommend new extended Pawlak rough set where real life problems can be solved. In this paper we displayed the importance of our extended method in identifying accurate tools to spot the major material properties in decision- making of material selection for selective industrial applications. This implicate removing attributes that do not meet the definite application to successfully produce a reduced set (d) and calculate the major attributes (properties) of Objects (materials). Finally an algorithm is written which helps the engineers/ researchers in identifying specific properties in more complex material systems.

Keywords: Material selection, Pawlak rough set, Nano topology, Binary relation, Topology control algorithm, Decision making model.

Mathematical Subject Classification 2020: 54C60, 74A40, 91A44.





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INTRODUCTION

Recently researchers have found many materials suitable for different applications. This selection of applications are majorly based on their properties. However, the material has to be analyzed for different behavior before selecting them for suitable application. This requires the knowledge of identifying the major properties within the list of material properties. The theory of Rough sets was introduced by Z. Pawlak et al, [1] which involves equivalence relation concept to solve problems in real life. But Pawlak applications are restricted since it considers the information provided by the whole system alone. Thus to solve more complex difficult problems, many generalizations are proposed by mathematicians including general binary relation [2, 3, 4], preorder relation [5], similarity relation [6], reflexive relation [7], topological coverings [8, 9] and approaches [10, 11, 12, 13, 14] which failed to satisfy the set properties. The Pawlak theory of rough sets was further developed and incorporated in Topology by ML Thivagar et al, [15] which lead to the finding of new theory called Nano Topology. Many applied real life problems in physics, medicine, engineering, economics and science have been exposed by Thivagar et al. The concept of Nanotopology consists of rough set upper approximation, lower approximation, universal set, boundary condition, and empty set. In this paper on considering the multi-informative data (properties) we have reduced the topological attributes and relate the idea of generalized nano-topology to solve our problem on decision- making of material selection.

Definition 1.1 [17] Consider two sets A and B. Let R be a Binary relation that exists between A and B. This R can be defined as the set of ordered pairs(θ , ω) \in Rwhere θ \in Aand ω \in B (i.e, subset of the Cartesian product A \times B).

Note 1.1 R from A to A is called as the binary relation on A itself.

The ordered pair (θ, ω) means, ω is related to θ by R.Thus the above ordered pair can be denoted as $\theta R \omega$. We describe the $\theta R = \{\omega \in A: \theta A \omega\}$ (similarly, $R\theta = \{\omega \in A: \omega R\theta\}$) $\forall \theta \in A$.

Definition1.2 [17] The set A with binary relation is said to be:

- 1. Reflexive: If $\forall \theta \in A, \theta R \theta$.
- 2. Symmetric: If $\forall \theta, \omega \in A$ and $\theta R \omega$, then $\omega R \theta$.
- 3. Transitive: If $\forall \theta, \omega, \rho \in A, \theta R \omega$ and $\omega R \rho$, then $\theta R \rho$.
- 4. Similarity or tolerance: If R satisfies (1) and (2).
- 5. Pre-order or dominance: If R satisfies (1) and (3).
- 6. Equivalence: If R satisfies (1), (2) and (3).

Definition 1.3 [2] Let H be a universe with binary relation, and then we define the Right Neighborhood $\forall \alpha \in \text{Has}$: $N_r(\alpha) = \{\beta \in \text{H}: \alpha R \beta\}$.

Definition 1.4 [16] Let H be a universe with binary relation, and then we define the Initial Neighborhood $\forall \alpha \in \text{Has}$:

 $N_i(\alpha) = {\beta \in H: N_r(\alpha) \subseteq N_r(\beta)}.$

For $A \subseteq H$ its lower and upper approximations are:

 $L_i(A) = {\beta \in H: N_i(\beta) \subseteq A}.$

 $U_i(A) = \{ \beta \in H: N_i(\beta) \cap A \neq \emptyset \}.$

Nano Topology (Generalized) and its application:

Using the concept of generalized rough sets, the notion for Nano topology is expanded [15]. To generate this topology, necessary conditions were proposed using Yao [2], Dai [18], and Allam [3]. We demonstrate selective industrial application to propose that the following technique can be used in decision making of material selection. The technique and algorithm for applying this new approach is mentioned in detail.





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Definition 2.1 [15] Let the universe U be a finite set, $U \neq \emptyset$. Let $X \subseteq U$ with an equivalence relation R on U named as the indiscernibility relation. The pair (U, R) is said to be the approximation space.

- 1. The lower approximation of X with respect to R (i.e , $L_R(X)$) is defined as follows : $L_R(X) = \bigcup_x \in U\{R(x): R(x) \subseteq X\}$, where R(x) denotes the equivalence class determined by x.
- 2. The upper approximation of X with respect to R (i.e , $U_R(X)$) is defined as follows : $U_R(X) = U_x \in U\{R(x): R(x) \cap X \neq \emptyset\}$.
- 3. The Boundary region of X with respect to R (i.e , $B_R(X)$) is defined as follows: $B_R(X) = U_R(X) L_R(X)$.

Definition 2.2[15] Let U be the universe with an equivalence relation R. Then $\tau_R(X) = \{ \cup, \emptyset, L_R(X), U_R(X), B_R(X) \}$ where $X \subseteq U$, satisfies the following axioms:

- 1. U and $\emptyset \in \tau_R(x)$.
- 2. The union of the any elements of $\tau_R(X)$ is $in\tau_R(X)$.
- 3. The intersection of the finite elements of $\tau_R(X)$ is in $\tau_R(X)$.

Thus the topology $\tau_R(X)$ is called the nano topology with respect to X. $(U,\tau_R(X))$ is called the nano topological space.

Remark 2.1 In Definition 1.1 the Lower approximation, Upper approximations, and Boundary conditions have been introduced using Pawlak's Rough set properties [1].

Nano-Topology (Generalized) and its properties:

If we extend the concept of Nano topology to generalized form using any generalized rough sets, then the generalized Nano topology is denoted ast^{gn}.

Theorem 2.1 [16] Let X be a finite set and $A \subseteq X$. There exist a binary relation R such that $\tau_k^{gn} = \{X, \emptyset, L_k(A), U_k(A), B_k(A)\}$ is a gn-topology on X iff

- 1. R is a pre-order relation if k = r.
- 2. R is a similarity relation if k = u.
- 3. R is a reflexive relation if k = n.
- 4. R is a general binary relation if k = i.

i.e, the above conditions are Approach of Yao, Dai, Allam and Current.

Lemma 2.1 [16] Let U be a finite set. Then the base of the topology τ_{gn} for $A \subseteq U$ is given by: $b_k^{gn} = \{U, L_k(A), B_k(A)\}, \ \forall \ k \in \{r, i, n, u\}$

Applications on Material Selection

The main objective of this paper is to display the importance of our method in identifying accurate tools to spot the major properties of materials. We use general binary relation to show the importance of this method in decision-making of material selection for selective industrial applications. This method involves removing attributes that do not meet the specified application to successfully produce a reduced set (d) and calculate the major attributes (properties) of Objects (materials). As the attributes of Fe-Co-Si, Fe-B-Si, Fe-Cu-Si, Fe-P-B-Si, Fe-B-Si-Nb, Fe-C-P-B-Si-Mo are similar, the object is reduced to 8 and the list of properties are reduced to 6 i.e., Saturation Flux, Mechanical Property, Electrical resistivity, Stability with Age, Stability with Temperature, and Permeability.

Note 3.1 The set of Objects are taken as $U=\{h_1,h_2,h_3,h_4,h_5,h_6,h_7,h_8\}$ representing different set of materials, the attributes are $\{a_1,a_2,a_3,a_3,a_4,a_5,a_6\}$ the following information is collected from literature review.

Material selection and decision making for transformer application

The property of every element obtained from Table 1 for Transformer Application is given as:





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$$v(h_1) = \{a_1\}, v(h_2) = \{a_6\}, v(h_3) = \{a_2, a_3, a_4\}, v(h_4) = \{a_1, a_2\}, v(h_5) = \{a_1\}, v(h_6) = \{a_4, a_5, a_6\}, v(h_7) = \{a_1, a_3\}, v(h_8) = \{a_1, a_3, a_6\}.$$
 where, $v(h_8) = v(h_9) = v(h_{10}) = v(h_{11}) = v(h_{12}) = v(h_{13})$ Now generating the following relation,

 $v = \{h_1, h_2, h_3, h_4, h_5, h_6, h_7, h_8\}$

 $V = \{n_1, n_2, n_3, n_4, n_5, n_6, n_7, n_8\}$

 $h_i R h_j \Leftrightarrow v(h_i) \subseteq v(h_j)$

 $R = \{(h_1, h_1), (h_1, h_4), (h_1, h_5), (h_1, h_7), (h_1, h_8), (h_2, h_2), (h_2, h_6), (h_2, h_8), (h_3, h_3), (h_4, h_4), (h_5, h_5), (h_5, h_1), (h_5, h_4), (h_5, h_7), (h_5, h_8), (h_6, h_6), (h_7, h_7), (h_7, h_8), (h_8, h_8)\}.$

Thus Right neighborhoods of each metal in U of this relation are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r(h_3) = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_8\}$$

Accordingly initial neighborhoods are

$$N_i(h_1) = \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_1, h_5, h_7\}, N_i(h_8) = \{h_1, h_2, h_5, h_7, h_8\}$$

Case 1: For Transformers (from table 2),

$$\begin{split} &\text{If } X = \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\} \\ &L_i(X) = \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\} \\ &U_i(X) = \{h_1, h_2, h_3, h_4, h_5, h_6, h_7, h_8\} = U \\ &B_i(X) = \{h_6\} \\ &\tau_i^{\text{gn}} = \{U, \emptyset, \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}, \{h_6\}\} \\ &b_i^{\text{gn}} = \{U, \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}, \{h_6\}\} \end{split}$$

Step 1: If a_1 is removed, then $X = \{h_2, h_3, h_8\}$.

$$v(h_1) = \emptyset, v(h_2) = \{a_6\}, v(h_3) = \{a_2, a_3, a_4\}, v(h_4) = \{a_2\}, v(h_5) = \emptyset, v(h_6) = \{a_4, a_5, a_6\}, v(h_7) = \{a_3\}, v(h_8) = \{a_3, a_6\}$$
. Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_5\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_3, h_4\}, N_r(h_5) = \{h_1, h_5\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_3, h_7, h_8\}, N_r(h_8) = \{h_8\}.$$

Our Initial Neighborhoods are,

$$N_i(h_1) = \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3, h_4, h_7\}, N_i(h_4) = \{h_4\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_7\}, N_i(h_8) = \{h_2, h_7, h_8\}$$

By theorem2.1 and Lemma2.1, Generalized topology of basis of X are as follows:

$$\tau_{i-a_1}^{\text{gn}} = \{U, \emptyset, \{h_2\}, \{h_2, h_3, h_6, h_8\}, \{h_3, h_6, h_8\}\} \neq \tau_i^{\text{gn}}$$

$$b_{i-a_1}^{\text{gn}} = \{U, \{h_2\}, \{h_2, h_3, h_6, h_8\}$$

 $b_i \neq b_{i-a_1}^{gn}$

Step 2: When a_2 is removed $X = \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}$.

$$v(h_1) = \{a_1\}, v(h_2) = \{a_6\}, v(h_3) = \{a_3, a_4\}, v(h_4) = \{a_1\}, v(h_5) = \{a_1\}, v(h_6) = \{a_4, a_5, a_6\}, v(h_7) = \{a_1, a_3\}, v(h_8) = \{a_1, a_3, a_6\}$$

Right neighborhoods of each Material are,

$$\begin{aligned} N_r(h_1) &= \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3) = \{h_3\}, N_r(h_4) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_8\}. \end{aligned}$$

Our Initial Neighborhoods are,

$$\begin{split} N_i(h_1) &= \{h_1, h_4, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_4, h_5\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_1, h_4, h_5, h_7\}, N_i(h_8) = \{h_1, h_2, h_4, h_5, h_7, h_8\} \\ \tau_{i-\alpha_2}^{\text{gn}} &= \{U, \emptyset, \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}, \{h_6\}\} = \tau_i^{\text{gn}}. \end{split}$$

$$b^{\rm gn}_{i-a_2} = \{U, \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}, \{h_6\}\}\;.$$





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$$b_i = b_{i-a_2}^{gn}$$

Step 3: When a_3 is removed $X = \{h_1, h_2, h_4, h_5, h_7, h_8\}$

$$v(h_1) = \{a_1\}, v(h_2) = \{a_6\}, v(h_3) = \{a_2, a_4\}, v(h_4) = \{a_1, a_2\}, v(h_5) = \{a_1\}, v(h_6) = \{a_4, a_5, a_6\}, v(h_7) = \{a_1\}, v(h_8) = \{a_1, a_6\}.$$

Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_8) = \{h_8\}.$$

Our Initial Neighborhoods are,

$$N_i(h_1) = \{h_1, h_5, h_7\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5, h_7\}, N_i(h_5) = \{h_1, h_5, h_7\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_1, h_5, h_7\}, N_i(h_8) = \{h_1, h_2, h_5, h_7, h_8\}.$$

$$\begin{split} \tau_{i-a_3}^{\rm gn} &= \{U,\emptyset,\{h_1,h_2,h_4,h_5,h_7,h_8\},\{h_6\}\} \neq \tau_i^{\rm gn}.\\ b_{i-a_3}^{\rm gn} &= \{U,\{h_1,h_2,h_4,h_5,h_7,h_8\},\{h_6\}\} \;. \end{split}$$

$$b_{i-a_3}^{gn} = \{U, \{h_1, h_2, h_4, h_5, h_7, h_8\}, \{h_6\}\}$$

$$b_i \neq b_{i-a_3}^{gn}$$

Step 4: When a_4 is removed $X = \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}$.

$$v(h_1) = \{a_1\}, v(h_2) = \{a_6\}, v(h_3) = \{a_2, a_3\}, v(h_4) = \{a_1, a_2\}, v(h_5) = \{a_1\}, v(h_6) = \{a_5, a_6\}, v(h_7) = \{a_1, a_3\}, v(h_8) = \{a_1, a_3, a_6\}.$$

Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_8\}.$$

Our Initial Neighborhoods are,

$$N_i(h_1) = \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_1, h_5, h_7\}, N_i(h_8) = \{h_1, h_2, h_5, h_7, h_8\}.$$

$$\tau_{i-a_4}^{\rm gn} = \{U,\emptyset,\{h_1,h_2,h_3,h_4,h_5,h_7,h_8\},\{h_6\}\} = \tau_i^{\rm gn}.$$

$$b_{i-a_4}^{\text{gn}} = \{U, \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}, \{h_6\}\} \ .b_i = b_{i-a_4}^{\text{gn}}$$

Step 5: When a_5 is removed $X = \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}$.

$$v(h_1) = \{a_1\}, v(h_2) = \{a_6\}, v(h_3) = \{a_2, a_3, a_4\}, v(h_4) = \{a_1, a_2\}, v(h_5) = \{a_1\}, v(h_6) = \{a_4, a_6\}, v(h_7) = \{a_1, a_3\}, v(h_8) = \{a_1, a_3, a_6\}.$$

Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_8\}.$$

Our Initial Neighborhoods are,

$$\begin{aligned} &N_i(h_1) = \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_1, h_5, h_7\}, N_i(h_8) = \{h_1, h_2, h_5, h_7, h_8\} \;. \end{aligned}$$

$$\tau_{i-a_5}^{\text{gn}} = \{U, \emptyset, \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}, \{h_6\}\} = \tau_i^{\text{gn}}.$$

$$b_{i-a_5}^{\text{rd}} = \{U, \{h_1, h_2, h_3, h_4, h_5, h_7, h_8\}, \{h_6\}\}.$$

$$b_i = b_{i-a_5}^{gn}$$

Step 6: When a_6 is removed $X = \{h_1, h_3, h_4, h_5, h_7, h_8\}$.

$$v(h_1) = \{a_1\}, v(h_2) = \emptyset, v(h_3) = \{a_2, a_3, a_4\}, v(h_4) = \{a_1, a_2\}, v(h_5) = \{a_1\}, v(h_6) = \{a_4, a_5\}, v(h_7) = \{a_1, a_3\}, v(h_8) = \{a_1, a_3\}.$$

Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_7, h_8\}.$$

Our Initial Neighborhoods are,





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$$\begin{split} N_i(h_1) &= \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_6\}, N_i(h_7) = \{h_1, h_5, h_7, h_8\}, N_i(h_8) = \{h_1, h_5, h_7, h_8\} . \\ \tau^{\rm gn}_{i-a_6} &= \{U, \emptyset, \{h_1, h_3, h_4, h_5, h_7, h_8\}, \emptyset \} . \\ b^{\rm gn}_{i-a_6} &= \{U, \{h_1, h_3, h_4, h_5, h_7, h_8\}, \emptyset \} . \\ b_i \neq b^{\rm gn}_{i-a_6} \end{split}$$

From step 1 - 6 it is observed that a_1 , a_3 , a_6 i.e, the Saturation flux, Electrical resistivity of permiability are the three major parameters to fabricate a transformer. Thus these are core or non-dispensable attributes.

Material selection and decision making for Pure Inductor Application

The property of every elements obtained from Table 1 for Pure Inductors Application is given as: $v(h_1) = \{b_1\}, v(h_2) = \{b_6\}, v(h_3) = \{b_2, b_3, b_4\}, v(h_4) = \{b_1, b_2\}, v(h_5) = \{b_1\}, v(h_6) = \{b_4, b_5, b_6\}, v(h_7) = \{b_1, b_3\}, v(h_8) = \{b_1, b_3, b_6\}.$

where, $v(h_8) = v(h_9) = v(h_{10}) = v(h_{11}) = v(h_{12}) = v(h_{13})$.

Now generating the following relation.

 $\mathbf{v} = \{h_1, h_2, h_3, h_4, h_5, h_6, h_7, h_8\}$

 $h_i R h_i \Leftrightarrow v(h_i) \subseteq v(h_i)$

 $R = \{(h_1, h_1), (h_1, h_4), (h_1, h_5), (h_1, h_7), (h_1, h_8), (h_2, h_2), (h_2, h_6), (h_2, h_8), (h_3, h_3), (h_4, h_4), (h_5, h_5), (h_5, h_1), (h_5, h_7), (h_5, h_7), (h_5, h_8), (h_6, h_6), (h_7, h_7), (h_7, h_8), (h_8, h_8)\}.$

Thus Right neighborhoods of each metal in U of this relation are ,

 $N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r(h_3) = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_7, h_8\}.$

Accordingly initial neighborhoods are

 $N_i(h_1) = \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_1, h_5, h_7, h_8\}, N_i(h_8) = \{h_1, h_5, h_7, h_8\}.$

Case 2: For Pure Inductors (from table 3),

If
$$X = \{h_1, h_2, h_3, h_4, h_7\}$$

 $L_i(X) = \{h_2, h_3\}$.
 $U_i(X) = \{h_1, h_2, h_3, h_4, h_5, h_6, h_7, h_8\} = U$
 $B_i(X) = \{h_1, h_4, h_5, h_6, h_7, h_8\}$.
 $\tau_i^{gn} = \{U, \emptyset, \{h_2, h_3\}, \{h_1, h_4, h_5, h_6, h_7, h_8\}\}$.
 $b_i^{gn} = \{U, \{h_2, h_3\}, \{h_1, h_4, h_5, h_6, h_7, h_8\}\}$.

Step 1: If b_1 is removed, then $X = \{h_2, h_3, h_7\}$.

 $v(h_1) = \emptyset, v(h_2) = \{b_6\}, v(h_3) = \{b_2, b_3, b_4\}, v(h_4) = \{b_2\}, v(h_5) = \emptyset, v(h_6) = \{b_4, b_5, b_6\}, v(h_7) = \{b_3\}, v(h_8) = \{b_3, b_6\}$. Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_5\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_3, h_4\}, N_r(h_5) = \{h_1, h_5\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_3, h_7, h_8\}, N_r(h_8) = \{h_8\}.$$

Our Initial Neighborhoods are,

 $N_i(h_1) = \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_4\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_6\}, N_i(h_7) = \{h_7\}, N_i(h_8) = \{h_8\}.$

$$\begin{split} \tau_{i-b_1}^{\mathrm{gn}} &= \{U,\emptyset,\{h_2,h_3,h_7\},\} \neq \tau_i^{\mathrm{gn}} \\ b_{i-b_1}^{\mathrm{gn}} &= \{U,\emptyset,\{,\{h_2,h_3,h_7\}\} \end{split}$$

$$b_i \neq b_{i-b_1}^{gn}$$





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Step 2: When b_2 is removed $X = \{h_1, h_2, h_3, h_4, h_7\}$.

$$v(h_1) = \{b_1\}, v(h_2) = \{b_6\}, v(h_3) = \{b_3, b_4\}, v(h_4) = \{b_1\}, v(h_5) = \{b_1\}, v(h_6) = \{b_4, b_5, b_6\}, v(h_7) = \{b_1, b_3\}, v(h_8) = \{b_1, b_3, b_6\}.$$

Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_8\}.$$

Our Initial Neighborhoods are,

$$N_i(h_1) = \{h_1, h_4, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_4, h_5\}, N_i(h_6) = \{h_6\}, N_i(h_7) = \{h_7\}, N_i(h_8) = \{h_8\}.$$

$$\tau_{i-h_2}^{\rm gn} = \{U,\emptyset,\{h_2,h_3,h_7\},\{h_1,h_2,h_3,h_4,h_5,h_7\},\{h_1,h_4,h_5\}\} \neq \tau_i^{\rm gn}.$$

$$\mathbf{b}^{\mathrm{gn}}_{i-b_2} = \{U, \{h_2, h_3, h_7\}, \{h_1, h_4, h_5\}\}\;.$$

$$b_i \neq b_{i-a_2}^{gn}$$

Step 3: When b_3 is removed $X = \{h_1, h_2, h_4, h_7\}$.

$$v(h_1) = \{b_1\}, v(h_2) = \{b_6\}, v(h_3) = \{b_2, b_4\}, v(h_4) = \{b_1, b_2\}, v(h_5) = \{b_1\}, v(h_6) = \{b_4, b_5, b_6\}, v(h_7) = \{b_1\}, v(h_8) = \{b_1, b_6\}.$$

Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_8) = \{h_8\}.$$

Our Initial Neighborhoods are,

$$N_i(h_1) = \{h_1, h_5, h_7\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5, h_7\}, N_i(h_5) = \{h_1, h_5, h_7\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_1, h_5, h_7\}, N_i(h_8) = \{h_1, h_2, h_5, h_7, h_8\}.$$

$$\begin{split} \tau^{\rm gn}_{i-b_3} = & \{U,\emptyset,\{h_2\},\{h_1,h_2,h_4,h_5,h_7,h_8\},\{h_1,h_4,h_5,h_6,h_7,h_8\}\} \neq \tau^{\rm gn}_i.\\ b^{\rm gn}_{i-a_3} = & \{U,\{h_2\},\{h_1,h_4,h_5,h_6,h_7,h_8\}\}\;.\\ b_i \neq b^{\rm gn}_{i-b_2} \end{split}$$

Step 4: When b_4 is removed $X = \{h_1, h_2, h_3, h_4, h_7\}$.

$$v(h_1) = \{b_1\}, v(h_2) = \{b_6\}, v(h_3) = \{b_2, b_3\}, v(h_4) = \{b_1, b_2\}, v(h_5) = \{b_1\}, v(h_6) = \{b_5, b_6\}, v(h_7) = \{b_1, b_3\}, v(h_8) = \{b_1, b_3, b_6\}.$$

Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_8\}.$$

Our Initial Neighborhoods are,

$$N_i(h_1) = \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_1, h_5, h_7\}, N_i(h_8) = \{h_1, h_2, h_5, h_7, h_8\}.$$

$$\begin{split} \tau_{i-b_4}^{\rm gn} &= \{U,\emptyset,\{h_2,h_3\},\{h_1,h_4,h_5,h_6,h_7,h_8\}\} = \tau_i^{\rm gn}, \\ b_{i-b_4}^{\rm gn} &= \{U,\{h_2,h_3\},\{h_1,h_4,h_5,h_6,h_7,h_8\}\} \;. \end{split}$$

$$b_i = b_{i-b_4}^{gn}$$





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Step 5: When b_5 is removed $X = \{h_1, h_2, h_3, h_4, h_7\}$.

$$v(h_1) = \{b_1\}, v(h_2) = \{b_6\}, v(h_3) = \{b_2, b_3, b_4\}, v(h_4) = \{b_1, b_2\}, v(h_5) = \{b_1\}, v(h_6) = \{b_4, b_6\}, v(h_7) = \{b_1, b_3\}, v(h_8) = \{b_1, b_3, b_6\}.$$

Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2, h_6, h_8\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_8\}.$$

Our Initial Neighborhoods are,

$$N_i(h_1) = \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_2, h_6\}, N_i(h_7) = \{h_1, h_5, h_7\}, N_i(h_8) = \{h_1, h_2, h_5, h_7, h_8\}$$

The above Right Neighborhood is similar to N_r obtained in step 4, When b_4 is removed thus

$$\tau_{i-b_5}^{\text{gn}} = \{U, \emptyset, \{h_2, h_3\}, \{h_1, h_4, h_5, h_6, h_7, h_8\}\} = \tau_i^{\text{gn}}.$$

$$\vec{b}_{i-b_5}^{\rm gn} = \{U, \{h_2, h_3\}, \{h_1, h_4, h_5, h_6, h_7, h_8\}\}.$$

 $b_i = b_{i-b_5}^{gn}$

Step 6: When b_6 is removed $X = \{h_1, h_3, h_4, h_7\}$.

$$v(h_1) = \{b_1\}, v(h_2) = \emptyset, v(h_3) = \{b_2, b_3, b_4\}, v(h_4) = \{b_1, b_2\}, v(h_5) = \{b_1\}, v(h_6) = \{b_4, b_5\}, v(h_7) = \{b_1, b_3\}, v(h_8) = \{b_1, b_3\}.$$

Right neighborhoods of each Material are,

$$N_r(h_1) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_2) = \{h_2\}, N_r\{h_3\} = \{h_3\}, N_r(h_4) = \{h_4\}, N_r(h_5) = \{h_1, h_4, h_5, h_7, h_8\}, N_r(h_6) = \{h_6\}, N_r(h_7) = \{h_7, h_8\}, N_r(h_8) = \{h_7, h_8\}.$$

Our Initial Neighborhoods are,

$$N_i(h_1) = \{h_1, h_5\}, N_i(h_2) = \{h_2\}, N_i(h_3) = \{h_3\}, N_i(h_4) = \{h_1, h_4, h_5\}, N_i(h_5) = \{h_1, h_5\}, N_i(h_6) = \{h_6\}, N_i(h_7) = \{h_1, h_5, h_7, h_8\}, N_i(h_8) = \{h_1, h_5, h_7, h_8\}.$$

$$\begin{split} \tau^{\mathrm{gn}}_{i-b_6} &= \{U,\emptyset,\{h_3\},\{h_1,h_3,h_4,h_5,h_7,h_8\},\{h_1,h_4,h_5,h_7,h_8\}\} \neq \tau^{\mathrm{gn}}_i.\\ b^{\mathrm{gn}}_{i-b_6} &= \{U,\{h_3\},\{h_1,h_4,h_5,h_7,h_8\},\emptyset\}\:.\\ b_i &\neq b^{\mathrm{gn}}_{i-b_6} \end{split}$$

Thus from step 1 to 6 we can observe that b_1 , b_2 , b_3 and b_6 are dispensable attributes.

Material selection and decision making for Filter Application

Similar approach made for transformer and inductor applications can be followed to identify the major attributes for filter application as shown in table 4. The following (table 5) is the decision making algorithm via initial-approximation for above mentioned approaches (d_1, d_2, d_3) .

CONCLUSION

We have successfully utilized the concept of Nanotopology in general binary relation by expanding Pawlak theory of rough sets. In this paper the method of removing attributes to successfully produce a reduced set (d), have been used to calculate the major attributes (properties) of Objects (materials) for transformer and inductor application. The final Algorithm can be used to calculate similar major attributes for any objects in material science, medicine and engineering.

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Data availability

The data sets generated during and/or analyzed during the current study are available from the Corresponding author on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table.1. The Application decisions data set.

Soft	Педр	prication dec	isions data set	•							
Magneti c Material		General Properties									
Alloys	symbol	Saturatio n Flux	Mechanica 1 Property	Electrical resistivit y	Stabilit y with Age	Stability with Temperatur e	Permeabilit y	Transfor mer	Pure inductor	Filter	
Pure Fe	h ₁	high	low	low	low	low	low	Ye s	Ye s	Ye s	
Fe-Ni	h ₂	low	low	low	low	low	high	Ye s	Ye s	No	
Fe-Si	h ₃	low	high	high	high	low	low	Ye s	Ye s	No	
Fe-P	h ₄	high	high	low	low	low	low	Ye s	Ye s	No	
Fe-Co	h ₅	high	low	low	low	low	low	Ye s	No	Ye s	
Fe-Ni- Mo	h ₆	low	low	low	high	high	high	No	No	Ye s	
Soft ferrite	h ₇	high	low	high	low	low	low	Ye s	Ye s	Ye s	
Fe-Co-Si		high	low	high	low	low	high	Ye s	No	No	
Fe-B-Si		high	low	high	low	low	high	Ye s	No	No	
Fe-Cu-Si	h ₈	high	low	high	low	low	high	Ye s	No	No	
Fe-P-B-Si	110	high	low	high	low	low	high	Ye s	No	No	
Fe-B-Si- Nb		high	low	high	low	low	high	Ye s	No	No	
Fe-C-P- B-Si-Mo		high	low	high	low	low	high	Ye s	No	No	

Table.2. Consistent part of table 1 for transformer application.

Objects				Decision					
	a1	a2	d ₁						
h ₁	2	1	1	1	1	1	2		
h ₂	1	1	1	1	1	2	2		
h ₃	1	2	2	2	1	1	2		
h ₄	2	2	1	1	1	1	2		





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h ₅	2	1	1	1	1	1	2
h ₆	1	1	1	2	2	2	1
h ₇	2	1	2	1	1	1	2
h ₈	2	1	2	1	1	2	2

Table.3. Consistent part of table 1 for pure inductor application.

Objects	Attributes						Decision
	b1	b2	b3	b4	b5	b6	d_2
h ₁	2	1	1	1	1	1	2
h ₂	1	1	1	1	1	2	2
h ₃	1	2	2	2	1	1	2
h ₄	2	2	1	1	1	1	2
h ₅	2	1	1	1	1	1	1
h ₆	1	1	1	2	2	2	1
h ₇	2	1	2	1	1	1	2
h ₈	2	1	2	1	1	2	1

Table.4. Consistent part of table 1 for filter application.

Objects	Attributes						Decision
	c1	c2	c3	c4	c5	с6	d_3
h ₁	2	1	1	1	1	1	2
h ₂	1	1	1	1	1	2	1
h ₃	1	2	2	2	1	1	1
h ₄	2	2	1	1	1	1	1
h ₅	2	1	1	1	1	1	2
h ₆	1	1	1	2	2	2	2
h ₇	2	1	2	1	1	1	2
h ₈	2	1	2	1	1	2	1

Table.5. Decision making Algorithm table

Steps	Algorithm
	Create an information table from Table.1 (as shown in Table 2 or 3 or 4) representing different properties as
1	attributes, materials as objects and entries in table as attribute values. This table provides input of finite
	universe U (decisions).
2	From Step 1 compute Objects N_i i.e., initial neighborhood using definition 3.1
3	From step 2 using definition 3.2, for a specific decision set $X \subseteq U$ calculate initial-lower approximation $L_i(X)$,
3	initial-upper approximation $U_i(X)$ and initial-boundary (X).
4	On U over X, produce General Topology $(\tau_i^g n)$ and base $(b_i^g n)$ using definition 4.1.
5	From Consistent part of table, remove an attribute a_1 from attribute condition (C) and find $L_i(X), U_i(X)$ and
3	$B_i(X)$ for decision set $X\subseteq U$ on $C-a_1$.
6	Produce General Topology $(\tau_{i-a_1}^g n)$ and base $(b_{i-a_1}^g n)$ using definition 4.1.
7	Repeat 5 and 6 steps for all other conditional attributes (C).
0	For the conditional attributes in which $b_{i-a_1}^g n \neq b_i^g n$ is the major property for the given specific application
8	(d).





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REVIEW ARTICLE

A Review on Patru (Poultice) for Eruvaai Mullai Noigal (Anorectal Diseases) Mentioned in Siddha Literature

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ABSTRACT

Siddha medicine, a traditional Indian medical system, is uniquely known for its ability to effectively treat the underlying causes of diseases and manage chronic conditions. One specialized procedure within Siddha medicine is Patru therapy, which falls under the Kaaram branch of external treatments. Patru involves topically applying a thick, semi-solid medicinal paste over the affected area of the body. The medicinal paste is prepared by coarsely grinding raw herbal drugs or extracting active compounds from herbs to form a concentrated formulation. This patru paste may optionally be heated before application. Anorectal disorders refer to conditions affecting the distal gastro-intestinal tract, specifically the anal canal and rectum. Symptoms include difficulty passing stools, faecal incontinence, rectal bleeding, anorectal pain and rectal prolapse. Anorectal disorders have a high worldwide prevalence, estimated to impact nearly 25% of the general population. The underlying pathology often involves structural or functional abnormalities of the anorectal anatomy or the associated pelvic floor muscles. Hence, Siddha Patru therapy offers a potential solution for holistic anorectal disorder management through topical medicinal treatment of the affected region. About 27 preparations are collected from

Keywords: Patru, Moolam(Haemorrhoids), Pouthiram(Fistula), Eruvaai Mullai Noi





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INTRODUCTION

The Siddha system of medicine is one of the traditional medical systems native to India. It stands out due to its inherent ability to cure underlying causes of disease and bring about sustained relief from chronic illnesses. The core objectives guiding Siddha treatment are: Elimination of root cause, Restoring adequate strength & immunity and Prevention of disease recurrence. The Siddha materia medica comprises a vast repertoire of formulations for internal consumption(Aga marunthugal) as well as external applications (Pura marunthugal). Under external therapies, techniques such as Poultice (Patru), Heat cauterization (Agni), Chemical cautery (Kaaram) and Surgery (Aruvai) are employed. Poultice or Patru refers to the topical application of a warm, soft mass prepared by blending herbs, minerals, metals along with natural adjuvants. Depending on the indication, the consistency may vary from semisolid pastes to bandages. The poultice is applied over affected body parts to relieve pain, heal wounds, drain toxins etc. Anorectal disorders encompass conditions affecting the distal gastrointestinal and pelvic floor anatomy. About 25% of people experience these issues at some point in their lives. Symptoms comprise painful defecation, faecal incontinence, rectal bleeding, sensation of incomplete emptying and prolapse of rectal tissue. Such morbidity severely impairs quality of life while warranting significant healthcare expenditure towards diagnosis and treatment. Statistics reveal Haemorrhoids (61.7%) and Anal fissures (14%) to be the most prevalent pathologies, followed by Anal fistulas (10.3%). Eventually, over two-thirds of patients undergo surgery due to intolerable symptoms or failure of conservative therapy. As per Siddha texts, Anorectal diseases (Eruvaai Noigal) manifest as distinct types namely Moolam, Pouthiram, Prolapse (Aasana vai vedippu), Moolapitham, Moola kaduppu etc. Aligning with rising acceptance of complementary medicine, there is renewed interest among practitioners and the public regarding non-invasive remedies mentioned in Siddha treatises. Although techniques such as Karanool and Pugai do address certain anorectal conditions, numerous other external treatment methods have been documented yet remain obscure. Therefore, this review aims to systematically compile data on the various Patru or poultices indicated for Anorectal diseases, from Siddha literature.

METHODOLOGY

Study Design

This study conducted a comprehensive review of existing Siddha medical literature pertaining to the use of *patru* (poultices) in the treatment of *Eruvaaimullainoi* (anorectal diseases). *Patru* refers to medicinal preparations applied externally to the body, often in the form of a poultice, paste, oil, or powder. *Eruvaaimullainoi* encompasses a range of anorectal conditions affecting the anal and rectal regions. The literature review aimed to summarize and evaluate all available writings in Siddha texts describing the formulas and methods of using *patru* to treat *EruvaaiMullai Noi*.

RESEARCH INSTRUMENT

A standardized data entry form was utilized to systematically extract and record relevant information from the Siddha texts reviewed. This form enabled consistent collection of details on the ingredients, methods of preparation, and procedures for application of the various *patru* used for *Eruvaaimullainoi* across the literature.

DATA COLLECTION

Data on Siddha *patru* for *EruvaaiMullai Noi* was gathered by thoroughly reviewing and identifying mentions in available Siddha medical texts spanning fundamental principles, materia medica, and therapeutic treatises. Multiple classical Siddha documents were accessed to compile an extensive dataset on this therapeutic topic.





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STATISTICAL ANALYSIS

The completed data entry forms were compiled and analyzed using Microsoft Office software tools. Descriptive statistics were generated to summarize key patterns in the data, including the most used ingredients, vehicles and additives, forms of patru preparation, and body areas of topical application for eruvaaimullainoi across the Siddha literature.

Patru (Medicated Poultice Therapy) - Standard Operative Procedure

Patru is a therapeutic technique in Siddha medicine that involves topical application of medicinal preparations to the body in poultice form. A patru is prepared by grinding herbs, minerals, metals or other ingredients into a fine powder. This powder is then mixed with a suitable liquid base, most commonly honey, ghee, herbal decoctions, milk, liquids expressed from herbs, oils, vinegar, or buttermilk among others. The resulting semi-solid paste is applied directly onto the affected area of the body and kept in place using bandages or other binding material. The duration for which the patru is kept on varies from 3 hours to 3 days, depending on the patient's condition and treatment protocol prescribed. Once the specified duration is complete, the patru is removed and the area on which it was applied washed thoroughly with water to remove any residual paste or poultice debris. Lukewarm water is most used for this cleansing, but cold water can also be used if indicated. Washing the area removes any remaining external dosage on the skin and prepares the site for subsequent assessment of therapeutic response and further treatment as required. The effects and objectives of patru therapy include softening and ripening of masses or abscesses to promote drainage and relief, improving local blood circulation, reducing pain and inflammation, cleansing infected wounds, extracting foreign materials, and closing fistulous tracts among others. The choice of ingredients, consistency of the paste, site and mode of application, and contact period are selected based on the specific condition being treated and therapeutic aims. Detailed operative protocols and treatment guidance for numerous diseases and symptoms using specialized patru formulations are provided extensively across Siddha literature.

RESULTS AND DISCUSSION

Chart 1:The data collected on patru (medicated poultice) formulations for anorectal diseases included preparations using various medicinal substance categories across Siddha medicine. Out of the total *patru* preparations documented, 11 were purely herbal preparations containing only plant-based ingredients. Additionally, 6 preparations involved the use of animal products, categorized in Siddha medicine as *jeevam*, along with herbal components. Another 5 *patru* formulations documented consisted of a combination of herbs and inorganic mineral or metallic ingredients. The remaining 4 were purely inorganic preparations containing only minerals or metals as ingredients.

1. Herbal *patru*: 12 preparations

Contains only ingredients of plant origin

2. Jeevampatru: 6 preparations

Contains animal-derived products + herbs

3. Herbo-mineral *patru*: 5 preparations

Contains herbs + inorganic minerals/metals

4. Mineral/Metallic *patru*: 4 preparations

Contains only inorganic mineral or metal ingredients

Chart 2: Out of the various anorectal diseases examined, *patru* therapy was found to be predominantly documented in Siddha literature for the treatment of two specific conditions - hemorrhoids and anal fistulas.

Within the total data collected, 14 different *patru* preparations were specifically indicated for the treatment of hemorrhoids. Additionally, 13 distinct patru formulations were mentioned for anal fistulas.





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Hemorrhoids - 14 patruformulations documented

Anal Fistulas- 13 patru formulations documented.

This data highlights the significant emphasis given in Siddha medicine to specialized external *patru* therapy in effectively managing common anorectal conditions - hemorrhoids and anal fistulas specifically.

Chart 3:The Siddha texts reviewed documented various *patru* preparations indicated for anorectal diseases. The specific texts along with the number of *patru* formulations they each contained for anorectal conditions are summarized as follows:

- 1. Agathiyar Rana Vaithiyam: 5 formulations
- 2. Anuboga Rana Vaithiyasinthamani: 4 formulations
- 3. Aathmaratchamirthammenum Vaithiya Saara Sankiragam: 4 formulations
- 4. AgathiyarAttavanaiVaagadam: 4 formulations
- 5. Virana KarappanRogaSigichai: 2 formulations
- 6. Thamizhar Thai Aruthuvam: 2 formulations
- 7. Gunapaadamthathu&jeevam: 1 formulation
- 8. Gunapaadammooligai: 2 formulations
- 9. Kattuvaithiyam: 1 formulation
- 10. PararasasegaraVaithiyam: 1 formulation
- 11. Theraiyar Vaithiyam-1000: 1 formulation

CONCLUSION

This literature review aimed to thoroughly compile data and information on the use of medicinal poultices (patru) in the treatment of anorectal diseases, as described in classical Siddha medical texts. The study aggregated extensive evidence from authoritative Siddha documents regarding specialized external preparations and topical applications of patrutailored to treating different anorectal diseases. A comprehensive inventory documenting the various ingredients, formulations, methods of preparation, and procedures for therapeutic application of Siddha patru used for various anorectal conditions was developed. This compiled inventory serves as a valuable consolidated resource that documents the wealth of knowledge in Siddha medicine pertaining to patru-based treatments for anorectal disorders. It can significantly enable and benefit both Siddha academicians and clinicians. Academically, this data provides authentic primary evidence about the principles and practices of Siddha external medications. Clinically, it offers physicians validated guidance on specialized formulations and protocols for patru therapy which can directly inform and enrich practice. Additionally, disseminating research findings on the efficacious use of patru external therapies in Siddha medicine can meaningfully contribute to enhanced global awareness about the uniqueness, rigor and comprehensive nature of Siddha medical system. Highlighting niche therapeutic areas like anorectal diseases can spur greater scientific investigation and adoption of little-known but impactful Siddha treatment modalities. Overall, wider publication and promotion of specialized clinical data on patru can facilitate wider acceptance and integration of Siddha medicine alongside conventional medical systems. This can lead to expanded utilization of authentic Siddha therapies like *patru* in providing effective and safe healthcare solutions globally.

ANNEXURE

AVSS- Aathmaratchamirthammenum vaithiyasaara sankiragam8

AAV-Agathiyarattavanai vaagadam⁵

ARV-Agathiyar rana vaithiyam9

ARVS- Anuboga Rana vaithiyasinthamani¹⁰

G-M- Gunapadam- Mooligai⁷

G-TJ- Gunapadam- Thathu&Jeevam4

KV-Kattuvaithiyam¹²

PV- Pararasasegara vaithiyam¹³





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TTM- Thamizhar Thai maruthuvam¹¹

TV- Theraiyar vaithiyam - 10006

VKRS- Virana Karappan Roga Sigichai¹⁴

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Table 1: Preparation of Patru (Poultice) for various Eruvaai Mullai Noi (Anorectal diseases)

Preparation	Ingredients	Indications	Reference
1	 ✓ Senkathaari veer ✓ Saaranai veer [Trianthema portulacastrum] ✓ Akaragaram [Anacyclus pyrethrum] ✓ Veluthapisin ✓ Kostam [Acorus calamus] ✓ Milagu [Piper nigrum] ✓ Karunjeeragam [Nigella sativa] ✓ Kadugu [Brassica nigra] ✓ Aamanakuennai [Castor oil] ✓ Neerpoolakilangu [Phyllanthus reticulatus] 	Pouthiram(Fistula in ano)	KV
2	 ✓ Gowri paadanam [Yellow oxide of arsenic] ✓ Thurusu [Copper sulphate] ✓ Thutham [Zinc sulphate] ✓ Seena kaaram [Alum] ✓ Sangu [Conch shell] ✓ Arithaaram [Yellow arsenic trisulphide] ✓ Sunnambukal[Limestone] ✓ Velerukkam[Calotropis gigentia] 	Moolam(Haemorrhoids)	PV





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	✓ Erukkam paal[Calotropis gigentia's latex]		
	✓ Vennai [Butter]		
	✓ Lingam [Red sulphide of mercury]		
	✓ Arithaaram [Yellow arsenic trisulphide]		
	✓ Kungilium [Shorea robusta]		
3	✓ Karunbavalam [Saccharum officinarum]	Pouthiram (Fistula in ano)	ARVS
	✓ Abini [Papaver somniferum]		
	✓ Perungayam [Ferrula asafoetida]		
	✓ Thirugukalli paal [Euphorbia tortilis]		
	✓ Paatharasam [Mercury or Hydrargyrum]		
	✓ Gandhagam [Sulphur]		
,	✓ Vengaayam [Allium cepa]	D (I' (E' L L L L L L L L L L L L L L L L L L L	A DATO
4	✓ Neervaalam [Croton tiglium]	Pouthiram (Fistula in ano)	ARVS
	✓ Perungayam [Ferula asafoetida]		
	✓ Thirugukalli paal [Euphorbia tortilis]		
	✓ Pavalam [Coral]		
	✓ Karunjeeragam [Nigella sativa]		
	✓ Abini [Papaver somniferum]		
	✓ Perungayam [Ferula asafoetida]		
5	✓ Naabi [Aconitum ferox]	Pouthiram (Fistula in ano)	ARVS
	✓ Vellaipondu [Allium sativum]		
	✓ Chithramoolam [Plumbago indica]		
	✓ Kalli saaru[Euphorbia ligularia]		
	✓ Abini [Papaver somniferum]		
	✓ Kadugu [Brassica nigra]		
	✓ Perungayam [Ferula asafoetida]		
6	✓ Neervaalam [Croton tiglium]	Pouthiram (Fistula in ano)	ARVS
	✓ Karumpavalam [Saccharum officinarum]		
	✓ Erukkamsaaru [Calotropis gigantea]		
	✓ Nervaalam [Croton tigilum]		
7	✓ Palasaaru [Citrus limon]	Pouthiram (Fistula in ano)	TV
			A A \$7
8	[y	Moolam (Haemorrhoids)	AAV
	✓ Sunnambu [Slacked lime]		A A T 7
9	✓ Aamaiodu [Tortoise's shell]	Moolam (Haemorrhoids)	AAV
		, ,	
10	✓ Elipulikai [The excreta of rat] or	M 1 (II	AAV
10	✓ Kilinchalparpam [Common oyster shell]	Moolam (Haemorrhoids)	
	✓ Munthirigai juice		
	✓ Avuri illai[Indigofera tinctoria]		
	✓ Maruthonri illai[Lawsonia inermis]		
	✓ Kundrimani[Abrus precatorius]		
	✓ Kalappai kizhangu[Gloriosa superba]		ARV
11	✓ Etti vithai[Strychnos nux vomica]	Pouthiram (Fistula in ano)	
	✓ Ganja[Cannabis sativa]		
	✓ Perumarathu pattai[Aristolochia indica]		
	✓ Vellai poondu[Alium sativum]		
	✓ Perungayam [Ferula asafoetida]		
12	✓ Iruvithul[Aconitum ferox]	Pouthiram (Fistula in ano)	ARV
1∠	✓ Arithaaram[Yellow arsenic trisulphide]	1 ommuni (1 istaia iii aito)	





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	,			
	✓ Moosambaram[Black bole]			
	✓ Perungayam [Ferula asafoetida]			
	✓ Lingam [Red sulphide of mercury]			
	✓ Kukil[Commiphoramukul]			
	✓ Abin [Pappaversomniferum]			
	✓ Thirugukalli paal [Euphorbia tirucalli]			
	✓ Paatharasam[Mercury]			
	✓ Gandhagam[Sulphur]			
	✓ Perungayam[Ferula asafoetida]		A DX7	
13	✓ Naabi[Aconitum ferox]	Pouthiram (Fistula in ano)	ARV	
	✓ Abini[Papaver somniferum]	, , , , , , , , , , , , , , , , , , ,		
	✓ Moosambaram[black bole]			
	✓ Thirugukallisaaru [Euphorbia tirucalli]			
	✓ Moosambaram[Black bole]			
	✓ Abini[Papaver somniferum]			
	✓ Naabi[Aconitum ferox]			
	✓ Chitramoola veer[Plumbago zeylanica]		ARV	
14	✓ Karunjeeragam[Nigella sativa]	Pouthiram (Fistula in ano)	1221,	
	✓ Perungayam[Ferula asafoetida]			
	✓ Vellaipondu [Allium sativum]			
	✓ Thirugukallisaaru [Euphorbia tirucalli]			
	✓ Abini[Pappaver somniferum]			
	✓ Perungayam[Ferula asafoetida]			
	✓ Moosambaram[Black bole]		ARV	
15	✓ Kadugu[Brassica juncea]	Pouthiram (Fistula in ano)	AKV	
	,			
	✓ Vaalaparuppu [Croton tinglium]✓ Erukkan illai saaru[Calotropis gigentia]			
	✓ Annabedhi (Green vitriol)		TTM	
16	✓ Annaoeani (Green ourtoi) ✓ Water	Moolam (Haemorrhoids)	1 1 1 1 1 1	
	7,447.			
	Surry (curring to surreu)			
17	✓ Milagu(Piper nigrum)✓ Poondu(Allium sativum)	Maalaus (Haansandaaida)	TTM	
17		Moolam (Haemorrhoids)		
	✓ Paruthi leaf 's juice (Gossypium arboretum) or			
	✓ Mathulam pinchu juice (Punica granatum)			
	✓ Porikaaram [Alum]		A \$ 100	
18	✓ Venkaram [Borax]	Moolam (Haemorrhoids)	AVSS	
	✓ savukkaram	, , ,		
	✓ Lemon juice			
	✓ Mutherukkamseviver,			
	✓ Chukku(Zingifer officinalis)			
	✓ Milagu(Piper nigrum)		AVSS	
19	✓ Thippili(Piper longum)	Moolam (Haemorrhoids)	11,00	
	✓ Omam (Carum copticum)			
	✓ Vilamichuver [Plectranthusvettiveroides]			
	✓ Buffalo's milk			
	✓ Perunkayam [Ferula asafoetida]			
20	✓ Padikaram [Alum]	Padikaram [Alum] Moolam (Haemorrhoids)		
20	✓ Sirattaikari [Coconut shell ash]	wiooium (Haemormoids)		
	✓ Lemon juice			
	·			

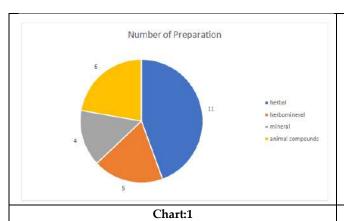




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21	 ✓ Maruthondri [Lawsoniainnermis] ✓ Karthigai kizhangu [Gloriosa superba] ✓ Neeli [Indigofera tinctoria] ✓ Etti [Strychnos nux-vomica] ✓ Kuntrimani [Abrus precatorius] ✓ Perumarathuverpattai [Aristolochia indica] ✓ Ganja [Cannabis sativa] ✓ Vasambu [Acorus calamus] ✓ Kaayam [Ferula asafoetida] ✓ Vellulli [Allium sativum] 	Pouthiram (Fistula in ano)	AVSS
22	✓ Neervaalam [Croton tingilium]✓ Lemon juice	Pouthiram (Fistula in ano)	AVSS
23	✓ KodiveliVeerpattai [Plumbago zeylanica]✓ Nalennai [Gingeley oil]	Moolam (Haemorrhoids)	G-M
24	 ✓ KottaikaranthaiVeerpattai [Ocimumbasilicum] ✓ Nalennai [Gingeley oil] 	Moolam (Haemorrhoids)	G-M
25	 ✓ Navacharam[Ammonium chloride] ✓ Yavatcharam[Pottasium carbonate] ✓ Seenakaram[Alum] ✓ Arisi [Oriza sativa] 	Moolam (Haemorrhoids)	AAV
26	✓ Pugan veer pattai	Moolam (Haemorrhoids)	VKRS
27	✓ Vengaram [Borax] ✓ Pandrinei	Moolam (Haemorrhoids)	G-TJ



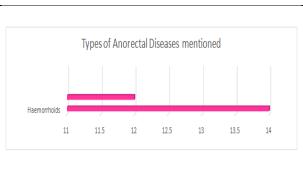


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RESEARCH ARTICLE

Effects of Telerehabilitation on Pain and Physical Function in Patients with Knee Osteoarthritis

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ABSTRACT

Telerehabilitation technologies are widely used to deliver health care, to monitor and toprovide rehabilitation services to people with musculoskeletal disorders. This study aimed to investigate the effects of telerehabilitation on pain and physical function in patients with knee osteoarthritis. The study was designed as a single-blinded randomized controlled trail, thirty-foureligible knee osteoarthritis patients were randomized into two groups; Telerehabilitation group (TRG,n= 17) and Centre-based rehabilitationgroup(CRG, n=17), Progressive structured exercise program was provided weekly for 4 weeks. Telerehabilitation group was supervised by video calls and text messages. Pain, knee muscle strength, Range of motion, and physical function were assessed at baseline, week 2, week 3 and week4. In addition, exercise adherence was assessed using the exercise adherence rating scale(EARS). Postintervention, pain, and physical function mean scores were 3.71(0.92), 4.71(0.77) and 77.5(9.56),77.45(9.72) for telerehabilitation and centre - based rehabilitation groups respectively. Improvements in pain, physical function, Range of motion, muscle strength were the same for both the groups. The study shows similar proposition of improvement at end of 4 week, indicate that tele rehabilitate could be viable option in the management of knee osteoarthritis. Telerehabilitation was as effective as the Centre-based rehabilitation in improving pain, and physical function. Exercise adherence was found to be effective in patients with KOA. Clinical Trial Registry - India (CTRI/2022/09/045221).





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Keywords: knee osteoarthritis, centre-based rehabilitation, telerehabilitation, pain, physical function, exercise adherence rating scale.

INTRODUCTION

Knee osteoarthritis (KOA) is the most prevalent musculoskeletal illness in adults and the elderly causing pain and disability and thereby burdening the healthcare system and society (1). According to estimates from the global burden of disease 2010 study, the number of years lost due to disability (YLDs – Years of Life Lived with Disability) for hip and knee OA increased from 0.79 million in 1990 (0.42 percent of total DALYs – Disability Adjusted Life Years) to 2.12 million in 2019 (0.69 percent of total DALYs). At present, 28.7% of the Indian population is overwhelmed with KOA (2). Rehabilitation of KOA patients is necessary to maximize people's functioning and quality of life by improving their abilities to live, work, and learn as much as viable (3). KOA management involves self-management promotion, pain reduction, optimization of function, and modifying the disease process and its effects. The first line of treatment for KOA includes patient education and exercise. Physical therapy is a mainstay for the treatment of osteoarthritis. It requires the patientsto visit specialized clinics for many sessions to yield maximized effect. Many middle-aged to elderly patients find it difficult to visit physiotherapy clinics several times a week especially if they live in remote locations. Tele-rehabilitation is defined as the provision of a rehabilitation service at a distance using telecommunications technology as a delivery medium (5,6). Tele-rehabilitation technologies are widely used to deliver primary care, monitoring, and rehabilitation services who are suffering from knee osteoarthritis (7).

When compared to centre-based treatment, telerehabilitation has been shown to improve access to health care because of its inherent flexibility (8). Telerehabilitation can provide recovery care to patients living in remote areas, it involves the use of massive data advances. Such administrations provide a wide range of procedures, including counselling, development, mediation, history, evaluation, and assessment (9). Due to the global pandemic situation, delivering center-based KOA rehabilitation to patients was challengingand it was difficult for patients who were in home isolation to reach the services. Telerehabilitation was widely used to deliver exercises to KOA patients who were homebound. The most widely used conservative management for KOA is therapeutic exercises and this can be best delivered to the KOA population as exercises are considered to be the safest form of management (10). Telebased exercise programming system have shown higher adherence to home exercise programs prescribed by a physical therapist when compared to traditional methods used by physical therapists to provide exercise regimens to patients with knee osteoarthritis. It can improve exercise confidence as well as contentment with the exercise delivery method (11). It has been found that telephone services delivered may be as effective as center-based physiotherapy treatment, and provide faster and safer access to physiotherapy. So, this study intended to investigate the effectiveness of telerehabilitation in patients with KOA and whether people with knee OA would adhere to an exercise therapy program delivered via telerehabilitation.

METHODOLOGY

This experimental study was approved by the Institutional Ethics Committee for students' projects, Sri Ramachandra Institute of Higher Education and Research (REF: CSP/22/APR/109/287). This study was registered in Clinical Trial Registry − India (CTRI/2022/09/045221).Patients referred to the outpatient physiotherapy department, Sri Ramachandra Hospital (G-Block), Chennai from Orthopedic units were recruited. The study process started in April 2022 and completed by August 2022.A verbal explanation of the research project was made followed by obtaining a written informed consent. Thirty-four patients who met the inclusion criteria were included for the study. Patients who were 45 years and above, complaining of activity—related knee pain for more 3 months, morning stiffness≤ 30 min, OA severity graded as GRADE 1 & 2 (KL grading), pain score of 4 and above, all the patients have an android mobile phone with text message functioning and be willing to use it during the study to receive and send text messages, were included for the study. Exclusion criteria included recent trauma,





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inflammatory arthritis, infective arthritis, knee joint replacement in the most painful knee, neurological procedure and Cognitive impairment, Inability to adhere to the protocol. Patients were randomized into two groups after obtaining written informed consent. The first group received telerehabilitation (TRG) and the second underwent centre-based rehabilitation (CRG)

Intervention

Subjects were randomly assigned into TRG and CRG respectively. Both groups received evidence-based knee conditioning program which included strengthening, stretching and range of motion exercise. The centre-based rehabilitation group received in department exercises program lasted for four weeks and included a weekly progression. Patients in the telerehabilitation group were instructed on how to perform each exercise and instructions to follow the directions via exercise demonstration video and manual. All patients received exercise demonstration videos through WhatsApp. Week 1 determined the participants' availability for regular phone calls. On weeks 2, 3, and 4, participants received a phone call from an investigator for at least 10 minutes to track their engagement to determine how often they exercised. The phone call was used to encourage participants to stick to the workout regimen. The centre-based group was treated in the rehabilitation centre under the supervision of the physiotherapist.

Pre and post-treatment evaluation

At baseline, demographic data, Pain intensity, Range of motion, Quadriceps and hamstring muscle strength and physical function were recorded. Pain was assessed using the Numerical pain rating scale(NPRS), Range of motion by inclinometer and muscle strength by a handheld dynamometer. Physical function was using Knee injury and osteoarthritis outcome score (KOOS). In addition, exercise adherence in the telerehabilitation group was assessing the exercise adherence rating scale. All the measurements repeated at three different time points (end of 2^{nd} , 3^{rd} & 4^{th} week).

STATISTICAL ANALYSIS

The collected data was analyzed with IBM.SPSS statistics software 28.0 Version. The descriptive statistics, percentage analysis were used for categorical variables and the mean & SD were used for continuous variables. The normality of the data was checked using the Shapiro-Wilk test and data was normally distributed.

RESULTS

Patient characteristics

34 patients were randomized into two treatment groups and all the patients completed the protocol, the mean age of participants was 52.76± 7.82 years (45–60), 73.5 % were female and 26.4% were male. The baseline characteristics of study patients are depicted in Table 1. Patients in both groups matched statistically.

Outcomes

The mean values of NPRS, KOOS, ROM, Flexor strength, extensor strength and EARS acquired by patients at table 2 shows between group comparison at 7th,14th,21st day for all outcomes. There is no statistically difference between the outcome measures indicating comparable improvement in both groups.

DISCUSSION

The study intended to explore the effects of telerehabilitation on pain and physical function in patients with KOA and to investigate whether people with KOA would adhere to exercise therapy programs via telerehabilitation. The results of the current study explained that telerehabilitation is as effective as centre-based rehabilitation in showing improvements in pain and physical function. Nowadays, there are more advantages to digital technology throughout the world. This digital technology is being incorporated into the field of physical therapy, which allows patients to maximize their potential in patient care and receive consistent evidence-based treatment. There are





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various telecommunication services such as websites, videoconferencing, smartphone apps, and telehealth. Various factors influence telerehabilitation to promote motivation and self-confidence to progress through regular phone calls. Previous studies say that center-based rehabilitation is more beneficial than telerehabilitation. On the contrary, in this study telerehabilitation show a similar effect as centre-based rehabilitation in KOA patients (12). In our study, outcomes were analyses at three different consecutive time intervals (7th, 14th, 21st) and all outcome shows statistical improvement in both groups. Recent studies found that telerehabilitation yielded a similar outcome as center-based physiotherapy (4). The NPRS has been an effective pain outcome in both groups. The MCID in NPRS for musculoskeletal condition is 2 (13) but in the current study MCID for the telerehabilitation group and centre- based rehabilitation group was 4 and 3respectively, stating improvement on pain in both groups. Regular communication and a coordinated approach are given by the therapist which enhances the better outcome in both groups. Teaching the patients how to reduce the severity of pain through appropriate pacing of exercises is important (14). The study results revealed that the effects of telerehabilitation on physical function showed improvement in both the groups. The MCID of KOOS for KOA was estimated to be 8.6 to 8.5 (15) from its baseline but the current study shows 8.5 in the telerehabilitation group and 7.26 in the centre-based group respectively. This is in concordance with the study done by Kamran Amza, an RCT that showed significant improvement in physical function (KOOS) from the baseline to 6 months post telerehabilitation (4).

Noninvasive management of KOA primarily involves exercises. Stretching exercises given to both groups have shown improvement in the knee ROM. Substantially, exercise enhances the proprioceptive mechanism of the knee joint, which results in the more typical joint excursion, and leads to a greater range of motion by reducing pain through persistent A-beta firing throughout these activities and aiding in pain control (16). Previous studies reported that rehabilitation mainly focused on quadriceps and hip musculature (17). Both groups received the similar exercises. In post-intervention flexor and extensor muscle strength showed improvement in both groups. Pain causes voluntary inhibition of muscles. Pain reduction improves quadriceps muscle function and prevents imbalance between muscle groups. This could be one of the reasons for improvements in both groups. Exercise training prevents cartilage degeneration inhibits inflammation and prevents subchondral bone erosion evidence indicates that exercises can improve pain, reduce joint stiffness and dysfunction, and improve knee function (18). In our study, the results are consistent in the previous mentioned study. Exercises adherence rating scale provides a valid and reliable adjunct of exercise adherence behavior regarding specific features of exercise prescriptions (e.g. FITT) (Emma Godfrey et al, 2017). Non-adherence to exercises may impose a specific challenge for telerehabilitation. Results of this study showed better exercise adherence, exercise satisfaction, and acceptability of exercise delivery in telerehabilitation than center-based rehabilitation group. In particular, devitalized patients who cannot be hospitalized for physical therapy management can benefit from telerehabilitation programs with similar effectiveness as long as they follow the recommended exercises (4). This study revealed that telerehabilitation is as effective as centre-based rehabilitation with less transportation, less cost, and less time.

LIMITATION

- Less sample size
- The study cannot be generalized to whole populations because the study population is less.

CONCLUSION

This study concluded that telerehabilitation is as effective as center-based rehabilitation. Both the groups showed a significant improvement in pain, physical function and also showed exercise adherence. Hence, telerehabilitation can be incorporated as a tool into our day-to-day rehabilitation strategy.

Disclosure statement

No potential conflict of interest was reported by the authors.





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Table 1: Demographic and baseline characteristics of the study groups Mean (SD)

	Tele rehabilitation group (TRG)	Centre based rehabilitation group (CRG)	
	Mean (SD)	Mean (SD)	P - value
Age	52.76±7.82	52.76±7.82	0.18
Gender(male/female)	3,14	6,11	NA
Side(right/left)	11,6	13,4	NA
Duration(months)	4.82±2.92	4.41±2.34	0.65
BMI	29.18±4.81	28.05±3.89	0.45
NPRS	7.29±0.68	7.00±0.61	0.19
KOOS	69.01±9.97	70.19±10.36	0.73
ROM	98.24±12.36	97.35±13.00	0.84
Flexor strength	5.04±0.89	4.75±0.97	0.37
Extensor strength	5.48±1.18	5.45±1.17	0.93

^{*}p<0.05, unpaired t- test; BMI- body mass index; NPRS - Numerical Pain Rating Scale; KOOS - Knee injury and osteoarthritis outcome survey; ROM-Range of motion

Table 2: Posttest (7th, 14th, 21st day) comparative analysis between the groups Mean (SD)

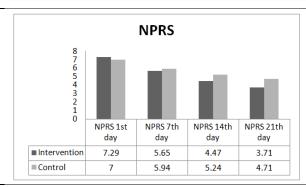
14010 2.1	7 th day			14th day			21st day		
Variable	TRG	CDC	p-	TRG	CRG	p-	TDC		
s	Mean(SD)	CRG Mean(SD)	valu e	Mean(SD)	Mean(SD)	valu e	TRG Mean(SD)	CRG Mean(SD)	p- value
NPRS	5.65±0.78	5.94±0.55	0.21	4.47±0.94	5.24±0.83	0.01*	3.71±0.92	4.71±0.77	0.002
KOOS	71.34±9.49	73.72±10.44	0.48	73.81±8.98	75.64±10.03	0.57	77.57±9.56	77.45±9.72	0.96
ROM	102.06±11.8 6	102.65±13.5 9	0.89	104.41±10.2 9	104.41±12.6 1	1	107.35±9.3 7	106.76±10.8 9	0.86
Flexor strength	5.64±1.17	5.54±1.17	0.8	6.05±1.29	5.92±1.18	0.76	6.44±1.34	6.11±1.13	0.44
Extenso r strength	6.04±1.00	6.08±1.13	0.89	6.65±0.94	6.44±1.14	0.57	6.98±0.95	6.60±1.12	0.29
EARS	46.94±7.70	44.65±8.92	0.42	48.65±7.62	46.76±8.36	0.49	50.41±7.62	48.65±8.17	0.52

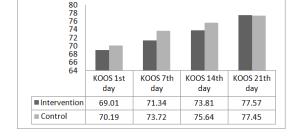
^{*}p<0.05,unpaired t- test; NPRS - Numerical pain rating scale; KOOS - knee injury and osteoarthritis outcome score; EARS - exercises adherence rating scale; ROM - Range of motion; TRG - Telerehabilitation Group; CRG - Centrebased Rehabilitation Group.





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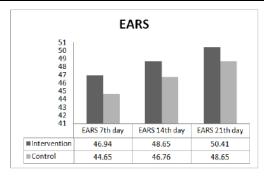




KOOS

Figure 1: Comparison of pain (NPRS) between the groups

Figure 2: Comparison of KOOS between the groups



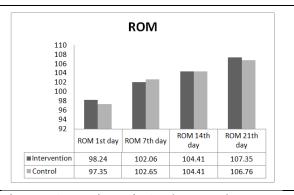
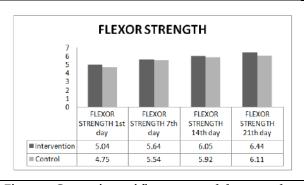


Figure 3: Comparison of EARS between the groups

Figure 4: Comparison of ROM between the groups



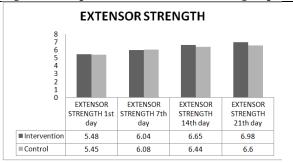


Figure 5: Comparison of flex or strength between the groups

Figure 6: Comparison of extensor strength between the groups





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RESEARCH ARTICLE

Robust Machine Learning for Anomaly Detection in Cyber Security

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ABSTRACT

In this paper, Robust Machine Learning for Anomaly Detection in Cyber security is introduced leveraging interpretability, Robust LIME (Local Interpretable Model-agnostic Explanations) enhances the transparency of anomaly detection models. It provides detailed insights into model predictions, facilitating effective cyber security threat analysis. The approach proves robust across diverse cyber threats, ensuring accurate and explainable anomaly detection.

Keywords: Machine Learning, Anomaly Detection, Cybersecurity, Interpretability, Threat Analysis

INTRODUCTION

The dynamic nature of cyber security presents formidable hurdles for conventional security measures due to the constantly changing nature of threats. The demand for sophisticated methods to identify anomalies and safeguard sensitive data is rising as cyber attacks get more complex. In the field of cyber security, robust machine learning (ML) has become a valuable tool since it provides a proactive method of spotting anomalies and possible dangers inside large, complicated datasets. An essential part of cyber security is anomaly detection, which looks for patterns and behaviors that don't match the norm. The complexity of contemporary cyber threats often outpaces traditional rulebased systems, which has sparked a boom in the use of machine learning algorithms for more intelligent and adaptive anomaly detection. The utilization of algorithms that can endure hostile attacks and sustain efficacy amidst dynamic circumstances is integral to the concept of robust machine learning in anomaly detection. In the field of cyber security, where attackers are always improving their methods to avoid discovery, this resilience is especially crucial. Cyber security experts can improve the robustness of their defenses by utilizing strong machine learning





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models. Robust machine learning has several advantages in anomaly detection, one of which is its flexibility in adjusting to novel and unforeseen patterns. Because conventional approaches rely on established criteria that might not cover all possible threats, they may not work when faced with fresh attack vectors. Conversely, strong machine learning models have the ability to extrapolate from current data in order to detect irregularities that might deviate from established trends. This allows for a more thorough protection against new and evolving cyber threats. Effective threat analysis and response depend on an understanding of the model's decision-making process. Interpretable models create a collaborative environment between human expertise and machine intelligence, enabling cyber security experts to trust and improve their systems. In the realm of cyber security, strong machine learning has become an essential tool for improving anomaly detection capabilities. Robust machine learning models provide an effective and proactive defense against constantly changing cyber threats by utilizing adversarial robustness, diversified datasets, and adaptive algorithms. Robust machine learning will play a critical role in strengthening organization defenses and guaranteeing the security of sensitive data in an increasingly digital world as the cyber security landscape continues to change.

Robust Machine Learning

It describes the creation and application of machine learning models that demonstrate efficacy and durability in a range of demanding scenarios. In this sense, "robust" refers to the models' capacity to continue operating and delivering results in the face of uncertainties, data fluctuations, or intentional attempts to manipulate the system. Ensuring openness and interpretability in decision-making, tackling adversarial attacks, managing noisy data, and responding to changing settings are just a few of the strategies and factors that go into building robust machine learning. The objective is to develop models that can function dependably in real-world conditions, yielding trustworthy results under a variety of input and condition scenarios.

Anomaly Detection in Cyber Security

One of the most important defense mechanisms in cyber security is anomaly detection, which looks for unusual patterns or behaviors in a system that could be signs of security flaws. By utilizing cutting-edge machine learning methods, these systems create a baseline of typical activity and quickly identify abnormalities. Their capacity to fend off deliberate manipulations via adversarial robustness, adjust to changing data distributions via transfer learning, and boost resilience through ensemble techniques is essential to their effectiveness. Explain ability guarantees transparent decision-making, empowering experts in cyber security to analyze and respond to detected irregularities. In the constantly changing field of digital security, anomaly detection systems help to create proactive, adaptive, and successful cyber security strategies by strengthening defense mechanisms against adversarial attacks and data drift.

LITERATURE SURVEY

Robust Online Evolving Anomaly Detection (ROEAD)

S. Han (2021) et al proposed Log-Based Anomaly Detection with Robust Feature Extraction and Online Learning. System logs are incredibly useful tools in the world of cloud computing for monitoring and debugging system status. Traditional machine learning algorithms such as SVM and Logistic Regression have excellent accuracy, but it also have drawbacks such as extensive training times and the assumption of clean data. The present research proposes the Robust Online Evolving Anomaly Detection (ROEAD) framework as a solution to these problems. ROEAD is a log collection, parsing, robust feature extraction, and live evolving anomaly detection system that works well in real-world circumstances and has promise for improving anomaly detection systems.

Principal Component Analysis (PCA)

A. Muhammad(2020) et.al proposed Robust Early Stage Botnet Detection using Machine Learning. Botnets are becoming a serious danger to cyber security since they make illegal operations like Distributed Denial of Service(DDOS) attacks, virus distribution, phishing, and identity theft easier to carry out. The early-stage detection capabilities of current botnet detection systems are lacking, and all of them are protocol-specific. This research





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presents an early-stage method to botnet identification using machine learning classifiers and feature selection approaches. The centralized architecture's emphasis on the Hypertext Transfer Protocol (HTTP) and Internet Relay Chat (IRC) protocols improves detection and yields better results than previous methods. Subsequent investigations ought to examine decentralized structures, tackling peer-to-peer botnets.

Explainable Artificial Intelligence (XAI)

P. Barnard (2022) et.al proposed Robust Network Intrusion Detection through Explainable Artificial Intelligence (XAI). A two-stage pipeline for reliable network intrusion detection is presented in this letter. These justifications are used in the second stage to train an auto encoder that can differentiate between known and unknown attacks. Testing on the NSL-KDD dataset shows that the system can accurately identify novel attacks, and its overall performance is on par with state-of-the-art efforts. The effectiveness of the pipeline comes from combining the supervised detection capabilities of XGBoost with the auto encoder's capacity to handle novel attack scenarios, outperforming previous approaches. Future research attempts to investigate automated network management duties and expand the pipeline for changing network difficulties.

PROPOSED METHODOLOGY

Robust machine learning for anomaly detection in cybersecurity is an advanced approach that leverages resilient algorithms to identify and mitigate security threats effectively. This methodology involves the development of machine learning models capable of recognizing patterns indicative of cyber anomalies with high accuracy.

Proposed Robust LIME for Anomaly Detection in Cyber Security Data Collection

Collecting diverse datasets with a mix of normal and anomalous cyber activities is crucial for robust model development. Real-world scenarios, encompassing various attack types, enhance the model's effectiveness by capturing the complexity of cybersecurity threats. This approach ensures that the model is well-trained to detect and understand a broad spectrum of potential cyber threats in practical environments.

Data Preprocessing

In the preprocessing phase for anomaly detection in cybersecurity, it is essential to address missing values, outliers, and noise in the dataset. By employing robust data cleaning techniques, we enhance the overall quality and reliability of the data. Additionally, feature engineering methods are applied to extract pertinent information, ensuring that the dataset is optimized for effective anomaly detection algorithms.

Feature Selection

In the preprocessing phase for gold price prediction, key techniques such as mutual information, correlation analysis, and recursive feature elimination are employed. These methods identify crucial features by assessing their relevance and impact on the prediction task. The focus is on attributes demonstrating substantial variations between normal and anomalous instances, ensuring that the selected features contribute meaningfully to the predictive model's accuracy and effectiveness.

Robust LIME Integration

The integration of Local Interpretable Model-agnostic Explanations (LIME) into the anomaly detection framework involves enhancing LIME to tackle the distinct challenges posed by cybersecurity data. Special attention is given to addressing temporal aspects and accommodating the diversity of attack patterns, ensuring that the explanations provided by LIME align with the intricate nature of anomalies in the cybersecurity domain.

LIME Explanation Generation

Utilizing Local Interpretable Model-agnostic Explanations (LIME), we generate explanations for the model's predictions in cybersecurity. These explanations are tailored to align with domain-specific knowledge, offering





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interpretable insights into detected anomalies. LIME enhances transparency, enabling cybersecurity professionals to understand and trust the model's decisions, ultimately improving the efficacy of anomaly detection in complex cyber landscapes.

Integration into Cybersecurity Systems

The interface development involves creating a user-friendly integration platform for the seamless inclusion of the anomaly detection model and LIME explanations into established cybersecurity systems. Prioritizing ease of use, cybersecurity professionals will have intuitive access to model outputs and interpretable explanations, enhancing their ability to analyze and respond effectively to detected anomalies in complex cyber environments.

Algorithm: Robust LIME

- Step 1: Gather labeled cyber security data, including both normal and anomalous instances.
- Step 2: Extract pertinent features from the dataset, capturing diverse facets of cyber activities.
- Step 3: Initialize LIME with parameters for perturbing data instances and generating local surrogate models.
- Step 4: Perturb instances around the data points to create a diverse set of local instances.
- Step 5: Train local surrogate models on the perturbed instances, mimicking the behavior of the underlying complex model
- Step 6: Integrate robustness measures to handle noisy and dynamic cyber data.
- Step 7: Calculate anomaly scores for instances based on the disparity between the complex model's predictions and local surrogate model predictions.
- Step 8: Set a threshold for anomaly scores to classify instances as normal or anomalous.
- Step 9: Evaluate the algorithm's performance, iterate if necessary, and optimize parameters for enhanced robustness and accuracy in anomaly detection for diverse cyber security scenarios. By following this comprehensive methodology, the integration of Robust LIME for anomaly detection in cybersecurity aims to provide a reliable, interpretable, and resilient solution for identifying and explaining anomalous activities in complex cyber landscapes.

EXPERIMENT RESULTS

Accuracy

The figure 1 Comparison chart of Accuracy values explain the different values of existing algorithms (PCA, XAI) and proposed ROBUST LIME. X axis denote the Nodes Accuracy in percentage and y axis denotes the Datasets. The existing algorithm values start from 20 to 65, 30 to 75 and proposed ROBUST LIME values starts from 50 to 95. The proposed method provides the better results.

Precision

The table 2 Comparison of Precision values explain the different values of existing algorithms (PCA, XAI) and proposed ROBUST LIME. While comparing the Existing algorithm (PCA, XAI) and proposed ROBUST LIME provides the better results. The figure 2 Comparison chart of Precision values explain the different values of existing algorithms (PCA, XAI) and proposed ROBUST LIME. X axis denote the Errors and y axis denotes the Datasets. The existing algorithm values start from 0.80 to 0.87, 0.91 to 0.97 and proposed ROBUST LIME values starts from 1.10 to 1.21. The proposed method provides the better results.

CONCLUSION

In this paper, Robust LIME (Local Interpretable Model-agnostic Explanations) emerges as a potent tool for anomaly detection in cybersecurity. Its ability to provide interpretable and locally faithful insights into complex models enhances the transparency of anomaly detection systems. By bridging the gap between model complexity and interpretability, Robust LIME empowers cybersecurity professionals to make informed decisions, fortifying the defense against cyber threats with a resilient and explainable framework.





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Table 1. Comparison of Accuracy

1								
Datasets	PCA	XAI	Proposed ROBUST LIME					
100	20	30	50					
200	35	45	65					
300	40	50	70					
400	55	65	85					
500	65	75	95					

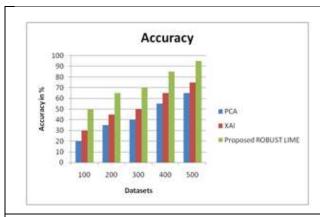
Table 2. Comparison of Precision

Datasets	PCA	XAI	Proposed ROBUST LIME
100	0.80	0.91	1.10
200	0.82	0.92	1.11
300	0.83	0.93	1.15
400	0.85	0.95	1.17
500	0.87	0.97	1.21





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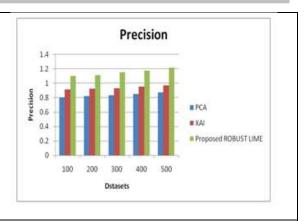


Figure 1.Comparison of chart Accuracy

Figure 2. Comparison of chart Precision





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RESEARCH ARTICLE

Greenwashing Understanding among Educated Women Consumer and Its Impact on their Green Consumption

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ABSTRACT

Many marketers are reconsidering the value of promoting their products as "green" in order to attract a growing environmentally conscious segment. And as a result they are attempting to improve their environmental standing by publicising their efforts. In order to attract a green audience, businesses frequently make environmental claims that are vague and, at times, false. To that end, they are employing green marketing strategies to gain a competitive advantage and appeal to environmentally conscious consumers. However, not all green marketing claims accurately reflect firms' environmental behaviour and can be considered 'Greenwashing'. Greenwashing is when a company pretend to be environmentally conscious for marketing purposes but actually isn't making any notable sustainability efforts. The Indian baby care market has experienced sustainable growth during the past few years. The market, which has long been considered as a niche segment in Indian perspective, has now transformed into the potential, fully fledged industry. As a result the greenwashing also has increased in this area. As the debate over greenwashing practises has intensified in recent years, consumers have become more aware of their options and have begun to understand companies' greenwashing practises. The goal of this empirical study is to assess greenwashing comprehension in Indian consumers' specially among the educated women's green purchasing behaviour, as well as the effects of receptivity to green advertising, environmental consciousness, and personal norms using the correlation and regression analysis. A survey was administered to collect responses from educated women and questionnaire construction





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process held with the help of previous studies which were distributed among them to know their valuable responses.

Keywords: Green washing, Receptivity to green advertising, Environmental consciousness, Personal norms, Green purchasing behaviour.

INTRODUCTION

Many marketers are reconsidering the value of promoting their products as "green" in order to attract a growing environmentally conscious segment. And as a result they are attempting to improve their environmental standing by publicising their efforts. In order to attract a green audience, businesses frequently make environmental claims that are vague and, at times, false. Sustainable growth has received a growing amount of consideration from both businesses and individuals as a result of the environmental disaster and other significant environmental issues(Zhang et al., 2018). In light of environmental concerns, customers are eager to acquire eco sound items(Chen et al., 2015). Over-communicating about a company's sustainability practices is known as "greenwashing" (Magali A;Delmas, 2011). Buyers might be more inclined to purchase a company's goods, even if they are more expensive, if they believe that the company is fulfilling its social obligation(Grimmer & Bingham, 2013). Conversely, people are less likely to purchase goods from businesses if they know they are Greenwashing after they become aware of it (Chen et al., 2014). According to recent research, buyers' opinions of Greenwashing have a detrimental impact on their willingness to make green purchases(Chen & Chang, 2013). Around 4 million babies are catered for annually by the worldwide baby product sector, which generates sales of close to \$7 billion (WHO, 2008). A wide variety of baby items are readily available on the market, and the list of such things keeps getting more and longer every day. India is among the globe's most desirable retail markets, resulting in a huge unexplored opportunity for baby, infant, and pregnancy care items (WHO, 2010). In this study, an effort was undertaken to gauge the understanding level of green washing in baby care product and the level of customer satisfaction among educated women as they are closely connected with the product item. Recent studies have found that consumers' perceptions of greenwashing negatively affect their propensity to undertake green goods (Kumar et al., 2011). This research is based on pro - environmental and how Indians perceive greenwashing. India is a developing country, therefore it is crucial to understand how customers there view greenwashing as well as how sensitive they are to ecological concerns. Additionally, given that much of the current study focuses on established countries, there is more room to undertake studies of green in India because it is a third world country. The study is focused on the educated women segment who are aware about the green washing.

REVIEW OF LITERARTURE

Butler et al.,(2016) found that functional economic and ecological values are considered to be more important to the value dimension for using energy efficiently where as social and emotion are tends to be less important. Sheth et al.,(1991) says about the theory of consumer choice and value and revealed excellent predictive validity. Varshneya & Das, (2017)gives an inference that fashion retail shoppers assess experiential value exclusively on the basis of privacy, trust, security, entertainment, enjoyment, and escapism. It is relevant that the customer gets self-oriented value when they admire an experience for themselves. And other –oriented values when they cherish the relationship of customers with others. Ghazali et al., (2017)- discuss that many consumers involved in purchasing greener product because of their health awareness and they give priority to their safety. Attitude is considered to the most important factor for the consumer to think about re-purchasing a product. Knowledge, hedonic value, safety value and environmental value are the key factor which constitute their attitude and re-purchase. Kates,(2000)- identified that the present situation of the environment is very poor and the only way to rescue the nature is practicing green consumption. So, the study says green consumption as a remedy for all the problems and issues in the nature due to over population. Peattie, (2001)in his studies found that individuals who are concerned more about the planet are





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perceived to adjust their buying habits in an effort to better the nature and are purposefully seen to favour greener products. The purchasing habits of the Indian medium sector, though, have undergone a striking transition as a response of altered financial circumstances and upper income levels. The involvement of customers is critical if a nation wants to implement the sustainable revolution (Tang et al., 2004). If a country wishes to achieve the environmentally friendly transformation, citizen participation is crucial(Nittala, 2014)." Guidelines for the use of environmental claims in advertising in India, are also provided by the legal regulatory framework, the Advertising Standards Council of India"-(ASCI). And those circumstances favour "greenwashing"(Baum, 2012). Aggarwal & Kadyan, (2014) Revealed that the personal care industry (62%) has the greatest average rate of greenwashing. Stamm et al., (2017) In order to market their product as sustainable and green, companies in this industry make greenwashing promises such "100% pure, biological, recyclable, ecologically friendly, and chemical free." These assertions might occasionally be false. Such false ecological claims can assist businesses in increasing their brief sales of goods and services

THEORETICAL UNDERSTANDING

Green Purchasing Behaviour

The term "green purchase behaviour" (GPB) has been debated recently in relation to the buying of green goods that don't impact the nature or community, or that are biodegradable and ecologically responsible (Chen & Chang, 2013; Mostafa, 2007; Rejikumar, 2016). Prior research has concentrated on a number of elements that affect GPB, including purchasing intention, attitudes, man-nature perspective, accountability, emotional and cognitive reaction, and individualism (Lau & Chan, 2000). Buyers are observed to exhibit fundamentally green habits by prioritising both value and quality when making purchases, and they also favour goods and companies that practise sustainability practices and preservation. Exploring the attitude-behaviour gap in consumers' decisions to make green purchases has been the primary priority of previous research on GPB.

Receptivity to Green Advertising

RGC measures how attentive, receptive, and favourable customers are to marketing ads that employs environmental message to advertise either an item or a business(Onditi, 2016). Various types of green arguments are used in promotion, and the way that various sorts of overtures are received by customers varies greatly (Banerjee et al., 1995; Obermiller & Spangenberg, 1998; Schuhwerk & Lefkoff-Hagius, 1995). Businesses use eco-friendly ads to demonstrate their sincere efforts to reduce the negative natural effects of its goods and services (Carlson et al., 1993). On the light of this knowledge, we suggest the following hypothesis

H1: RGC has a significant positive relationship with GPB for baby care products.

Environmental Consciousness

The extent that an individual is inclined to care about the nature is referred to as environmental awareness (EC) (Dunlap & Jones, 2002). It speaks of the mental elements that influence people's predisposition for environmentally friendly actions(Zelezny & Schultz, 2000). In the last twenty years, changing consumer habits have been brought on by growing ecological concerns(Hirsh, 2010). Becoming aware of the environment causes buying habits to change in favour of encouraging the development of ecologically aware behaviour, which boosts the need for reused and sustainable goods (Hamzaoui and Linton, 2010). For example, an investigation by Chaturvedi et al. (2020) examines the buying intentions of the current generation for recycled apparel, but with additional criteria aside from environmental considerations Chaturvedi et al. (2020). However, Bonera et al.'s (2020) results show that youngsters' consumption patterns appear to be less ecologically friendly, with nearly fifty percentage the participants ever buying reused paper items or using bags when they go purchasing, Bonera et al.'s (2020.). strong ecological concern individuals are more mature, social, and morally constrained over weak ecological interest individuals (strong dedication, appreciation for duties, and readiness to accomplish) (Brick and Lewis, 2014). Specifically, EC involves "converting environment morals into daily practise," or transforming ecological ideas into mental, physical, and emotional habit ((Bai & Romanycia, 2013, p. 105) EC is anticipated to have a part in ecological buying habits given the





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growth in cases of misrepresentation and manipulation of an item's health advantages (Souza & Trobe, 2005). An powerful determinant of top player conduct is ecological disaster (Roberts, 1996) that also encouraged customers to purchase eco-friendly goods (Ellen et al., 1991) and businesses that use environmental practices (Mishal et al., 2017). Based on this literature we framed the following hypothesis

H2: EC has a significant positive relationship with GPB for baby care products.

Personal Norms

PN is described as a moral duty to carry out or avoid from carrying out certain deeds(De Groot & Steg, 2009). Therefore, PN is a potent driver of sustainability practices because it is a set of standards of conduct that are regarded as emotions of ethical beliefs(Hopper & Nielsen, 1991; Stern & Dietz, 1994; Vining & Ebreo, 1992). The PN is evaluated for its contribution to ecological protection by utilizing and recycling sustainable goods in research on sustainable packaging(Nguyen et al., 2018) and significantly affects buyers' perceptions of sustainable goods and PNs have been revealed to have a special relationship with top player conduct(van der Werff et al., 2019). From this above mentioned theoretical review we can have the following hypothesis

H3: PN has a significant positive relationship with GPB for baby care products.

Understanding Greenwashing

In the last 20 years, sales promotion has roughly skyrocketed, but since 2006, it has nearly quadrupled again(Magali A;Delmas, 2011). Greenwashing is the practise of repeatedly portraying ecological promises in vague marketing such that buyers begin to doubt the sincerity of businesses(Furlow, 2010). According to the firm, greenwashing refers to selected declarations for which businesses reveal only positive green policies and measures while hiding unfavourable ones(Torelli et al., 2020). Through the use of "greenwashing," businesses deceive customers about the eco - friendly materials of their goods and offerings(Magali A;Delmas, 2011) A firm may use "greenwashing" to appear better ecologically benign than what it actually is(Topal et al., 2020) Unfortunately, through ages, buyers have learned about greenwashing, and as a result, businesses are lengthy lost revenues and buyers' faith(Kahraman & Kazançoğlu, 2019). By these we have following hypothesis:

H4: Levels of Greenwashing understanding has a significant positive relation with GPB for baby care products.

METHODOLOGY

Our research was done in India that is expected to have the largest population in the globe by 2025 as well as a greater customer base that prefers to engage in ethical or environmentally friendly purchasing. The Green index (2014) poll discovered that people in growing markets like China and India have a strong desire for natural items compared to advance such as the United States. This is in context of green consumption on a world basis. Additionally, this is demonstrated by the positive expansion of the baby care sector brought on by the new updates in Indians' lifestyles (Sudhakar & Rani, 2013) The reason for selecting the baby care product is that, according to the past studies baby care products are the most fast growing industries in India (62%)and also companies are adopting more greenwashing practices on this area (Aggarwal & Kadyan, 2014). The study also focus on the educated women segment of the society who are closely connected with the baby care products. As they are educated they may have a little idea about the companies advertising techniques and the ingredients of the products.

DATA COLLECTION AND SAMPLE PROFILE

Data were gathered using a validated interview, and the following methodology was examined. The elements chosen from already previous studies were utilised to quantify the numerous components employed in this investigation. The research data collected through questionnaires was intended for customers to consciously their observation and encounters when buying eco-friendly baby care items. Each scale was developed based on a Likert scale with 1 being "strongly disagree," 5 being "strongly agree".





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Random sampling method was adopted by distributing 150 questionnaire among different educated women who are neither graduate or post graduate or other streams. Out of which 116 questionnaires were returned back which is complete and used for future study. Table 1 shows the variables cronbach's alpha.

FINDINGS AND CONCLUSION

Correlation

Karl Pearson correlation was conducted in SSPSSv26 and it is found that there is a significant positive correlation between Average receptivity and Average Green purchasing behaviour (r = .249, p<0.00). And between average understanding about green washing and average green purchasing behaviour it is found a significant correlation of (r = .237, p <0.00). There found a low positive correlation between average environment and average green purchasing behaviour (r = .195, p <0.00). It also found that average personal norms and average green purchase behaviour has a significant correlation (r = .446, p <0.00). As the correlation values of all the variables are less than .80, there is no multi-collinearity.

Regression

Simple linear regression is used to measure how different variables predicts the green purchasing behaviour respondents. The following table 3 shows the result of the regression analysis.

- In average receptivity of green advertising the adjusted r square is .053 which means only 5.3% in the dependent variable green purchase behaviour is explained by the independent variable receptivity of green advertising.
- Coming to the next the adjusted r square is .048 which means 4.8% in the dependent variable green purchasing behaviour is explained by the independent variable of understanding about green washing.
- The independent variable of environmental consciousness which has adjusted r square value of .030 which explain only 3.0% of the dependent variable of green purchasing behaviour.
- In average personal norms the adjusted r square is .191 which says that 19% of the independent variable personal norm explains the dependent variable of green purchase behaviour.

CONCLUSION

This article studies about the green washing practices and the understanding about this among the educated women in baby care product. It examines the green purchasing behaviour towards baby product. The main objective of this study was to evaluate how well readers in the Indian context understood the factors that influence GPB in terms of greenwashing. In order to attain this objective, 'Receptivity to Green Advertising, environmental Consciousness, personal norms and understanding about the green washing' are the construct taken to study about the purchasing behaviour of respondents with the help of past reviews. The goal of the research was to learn more about the effects that RGC, PN, EC and Understanding Green washing, have on consumers' GPB of baby care items. The first and foremost findings of the study is that receptivity to green ads by the respondents have a role in their purchasing behaviour. How the customers perceive the green claims in advertisement provided by different companies about their product is considered as receptivity. Customers are therefore willing to purchase the company's goods when it claims in its advertisements that its products have environmentally friendly features. According to research, people in India are becoming more conscious of and perceptive of the "green washing" that is shown in advertisements and packaging of goods (Fernando et al., 2014). The next thing is that environment consciousness is also one of the factor which decides the green purchasing behaviour of the consumers. The level of how much an individual is inclined to care about the environment is referred to as environmental awareness. Therefore, when consumers are truly conscious of nature and the environment, they will undoubtedly consider their options before making a purchase. They will read the ingredient properly before buying the product. They also consider the packaging of the product. So it correlate with the green purchasing behaviour. Personal Norms are the next construct which taken into account. Personal norm is a strong driver of environmental conduct because it involves ethical expectations which are felt as ethical duties. From the analysis it is very clear that majority of the portion describes the beliefs and values of





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customer before buying the product. As we can see, green washing can be viewed and blamed in a variety of manners by those who are observing. It can be classified in a wide range of ways, from product-level assertions regarding environmental labelling to firm level nature-evoked executional aspects in sustainability reports. The diverse nature of greenwashing makes it difficult for customers to detect the phenomenon's symptoms. It is difficult to spot greenwashing even among customers deemed expert consumers, who are highly knowledgeable about false advertising and the product in question. The accusing procedure is much more problematic in ordinary customers who are unaware of or have little understanding about this trend.

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Table1: Variables Reliability

Variable	Author	No.of items in scale	Cronbach's alpha co- efficient
GPB	(Jaiswal & Singh, 2018)	4 item scale	.792
RGC	(Paço et al., 2019)	9 item scale	.731
EC	(Papista & Dimitriadis, 2019)	3 item scale	.846
PN	(Nguyen et al., 2018)	6 item scale	.851
Understanding Greenwashing	(Leonidou & Skarmeas, 2017)	5 item scale	.810

Table 2 correlation analysis

	AVRG_RECE	AVRG_UNDERS	AVRG_GRNBE	AVG_ENV	AVRG_PER
	PTIVITY	TANDING	HAVIOUR	RTMT	SONAL
AVRG_RECEPTI	Pearson	1			
VITY	Correlation	1			





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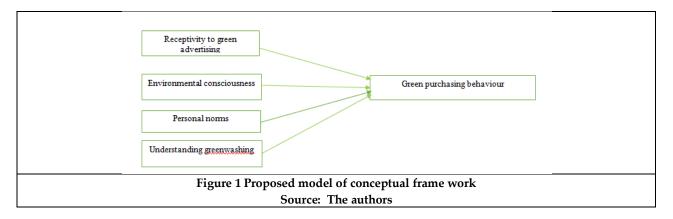
AVRG_UNDERS TANDING	Pearson Correlation	.204*	1		
TANDING	Correlation				
AVRG_GRNBEH	Pearson	.249**	.237*	1	
AVIOUR	Correlation	,249	.237	1	
ANG ENDERGE	Pearson	140	140	105*	1
AVG_ENVRTMT	Correlation	.149	.149	.195*	1
AVRG_PERSON	Pearson	.184*	.465**	.446**	.096
AL	Correlation	.104	.405	.440	.090

^{*.} Correlation is significant at the 0.05 level (2-tailed).

Table 3. Regression analysis

variable	R	R sqaure	Adjusted r square	t- stat	P value
Average RGC	.249	.062	.053	2.728	.000
Average understanding	.237	.056	.048	2.591	.000
Average EC	.195	.038	.030	2.116	.000
Average PN	.446	.198	.191	5.290	.000

Note: Dependent Variable - Green Purchasing Behaviour





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



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RESEARCH ARTICLE

Effects of Different Levels of Nutrient Management Practices for Production Enhancement on Yield and Economics in Irrigated Transplanted Ragi

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ABSTRACT

The field experiment was conducted in farmer's field at Golrur village, Bargur block, Krishnagiri district during summer season (March to July, 2021) to find out the effect of NPK levels, soil application of ZnSO₄, foliar spray of FeSO₄ and seaweed extract on the productivity of finger millet. The experiment was laid out in randomized block design and replicated trice. Among the different combinations of treatments tried, soil application of 125% RDF and ZnSO₄ @50 kg ha⁻¹ with foliar spray of FeSO₄ @ 0.2% on 20 DAT + seaweed extract @ 2.0% on 15 & 30 DAT (T10) significantly resulted in higher yield attributes and yield viz., number of earhead m⁻² (125.01), number of fingers earhead⁻¹ (10.66), number of grains earhead-1 (949.14), grain (3392 kgha-1) and straw yield (6589 kg ha-1) and benefit cost ratio of 2.89. Based on the results of present investigation, it can be concluded that treatment (T10) will holds immense potentiality to uplift the production and profitability of finger millet farmers under irrigated condition.

Keywords: Ragi, NPK levels, yield and economics.





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INTRODUCTION

Ragi is commonly known as "Nutritious millet" and also considered as wholesome food for diabetic patients and also major food crop of the semi-arid tropics of Asia and Africa and has been an indispensable component of farming systems (Goron et al., 2015). Among all food grains and cereals, millets has highest amount of iodine and calcium content. Finger millet is ranked fourth globally in importance of health benefits (Gupta et al., 2012) and has gained an important functional components such as slowly digestible starch and resistant starch Kumar, E. (2020). In Indian population, malnutrition and undernourishment are the major problem and millets are the promising foods for fighting hunger and malnutrition and potential for ensuring food and nutritional security. Nowadays millets are becoming an alternate source of human food globally as well as in India. Among various kinds of millets produced in India, finger millets production f accounts for about 85% (Divya, 2011) and is cultivated over an area of 1.61 million hectares with total production of about 2.1 million tonnes and productivity 1661 kg per hectare (AICSMIP, 2013-14). In Jharkhand, it is cultivated over an area of 0.490 mha with total production of about 27412 ton and productivity 684 kg per hectare (SAMETI GOJ, 2012-13). Besides this, the importance of micronutrients such as zinc and iron in improving the quality of food or value addition also needs to be evaluated to overcome the imbalance of nutrients in the produce. Micronutrients are essential for plant growth and play an important role in balanced crop nutrition. Micronutrients are as important to plant nutrition as primary and secondary nutrients, though plants do not require as much of them. They play major role in plant growth like protein synthesis, improving seed quality, cell division and pollen tube growth. Foliar applications of micronutrient sprays prove to be best to achieve both, Savithri et al., 1999. Foliar application of Zn and Fe brings the greatest benefit in comparison with addition to soil where they become less available.

MATERIALS AND METHODS

A Field experiment was conducted in a farmer's field at Golrur village, Bargur block of Krishnagiri district from March to July 2021 to study the influence of integrated nutrient management practices for growth and yield attributes on irrigated transplanted ragi. The experimental field was geographically located at 12°54' N latitude 78°35′ E longitude with altitude of 532 m above mean sea level in the North Western Agro- climatic zone of Tamilnadu. The weekly mean maximum temperature range from 30.3°C to 38.3°C with a mean of 33.9°C and the weekly mean minimum temperature range from 20.4°C to 25.8°C with a mean of 23.45°C. The relative humidity ranged from 40 per cent to 83 per cent with a mean of 66.15 per cent. The total rainfall received during the cropping period is 200.90 mm. The Soil of the experimental field was clay loam in texture. The available soil nitrogen, phosphorus and potassium were 240.00, 13.01 and 298.00 kg ha⁻¹ respectively. The experiment was laid out in Randomized Block Design (RBD) with three replications and ten treatments viz., 100% RDF (60:30:30 kg N, P2O5 and K2O ha-1) (T1), 100% RDF + ZnSO4 @ 50 kg ha-1 in soil (T2), 100% RDF + foliar spray of FeSO4 @ 0.2% on 20 DAT (T3), 100% RDF + foliar spray of seaweed extract @ 2.0% on 15 & 30 DAT (T₄), 100% RDF + ZnSO₄ @ 50 kg ha⁻¹ in soil + foliar spray of FeSO₄ @ 0.2% on 20 DAT + seaweed extract @ 2.0% on 15 & 30 DAT (T₅), 125% RDF (75: 37.5: 37.5 kg N, P₂O₅ and K₂O ha⁻¹) (T₆), 125% RDF + ZnSO₄ @ 50 kg ha⁻¹ in soil (T₇), 125% RDF + foliar spray of FeSO₄ @ 0.2% on 20 DAS (Ts), 125% RDF + foliar spray of seaweed extract @ 2.0% on 15 & 30 DAT (Ts) and 125% RDF + ZnSO4 @ 50 kg ha⁻¹ in soil + foliar spray of FeSO₄ @ 0.2% on 20 DAT + seaweed extract @ 2.0% on 15 & 30 DAT (T10). The Finger millet variety Co 15 was chosen for the study. The biometric observations were taken at critical stages of the crop.

Yield attributes and yield

Yield attributes and yield of ragi was significantly increased with combined application of organic and inorganic fertilizers with foliar spray of micronutrients (Table 2). Among the various treatments tried, application of 125% RDF+ ZnSO₄ @ 50 kg ha⁻¹ + foliar spray of FeSO₄ @ 0.2% and seaweed extract @ 2.0% at 15 & 30 DAT (T₁₀) recorded higher number of earheads m⁻² (125.01), number of fingers earhead⁻¹ (10.66), number of grains earhead⁻¹ (949.14), test weight (3.11 g), grain yield (3392 kg ha⁻¹) and straw yield (6589kg ha⁻¹). The least values for yield attributes and yield were recorded under the control (T1). The yield produced is indicative of the overall efficiency of resource utilisation and





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enhanced light interception. Due to the presence of various nutrients (Zn, Fe) and plant growth promoting substances in seaweed extract, the physiological characteristics of the plant could be governed by the increased availability of nutrients, resulting in maximum plant growth and yield attributing characteristics. The increase in the grain yield was also attributable to the improved physiology of plants with the added Zn and Fe which consequently corrected the efficiency of different enzymes and improved the nitrate conversion to ammonia in plant Sujatha *et al.* (2017).

Economics

The profitable outcome of crop can be achieved by the economic efficiency. Higher crop productivity leads to the better economic parameters such as gross income, net income and return per rupee invested. Cost of cultivation, gross return and net return increased with increase in addition of nutrients in combination with NPK and micro nutrients. Among the various treatments imposed in study, soil application of 125% RDF (75:37.5:37.5 kg of NPK ha⁻¹) and ZnSO₄ @ 50 kg ha⁻¹ with foliar spray of FeSO₄ @ 0.2% on 20 DAT + seaweed extract @ 2.0% on 15 & 30 DAT ha⁻¹ (T₁₀) recorded higher net return and benefit cost ratio of Rs. 77,453 and 2.89 respectively. Lower gross income, net income and benefit cost ratio of Rs.71,277, Rs.39,322 and 2.23 respectively were registered under control (T₁). The reasons attributed to lowest economic values under the treatment T₁ might be due to poor grain yield recorded under the control treatment Roy *et al.* (2018), Shankar Charate *et al.* (2017), and Thimmegowda *et al.* (2018).

CONCLUSION

Keeping in close view of the above options, it can be concluded that soil application of 125% NPK (75:37.5:37.5 kg ha⁻¹) and ZnSO₄ @ 50 kg ha⁻¹ with foliar spray of FeSO₄ @ 0.2% on 20 DAT and seaweed extract @ 2.0% on 15 & 30 DAT could be technologically feasible strategies for maximization of yield and profit for the farmers in irrigated transplanted finger millet.

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Table. 1 Effect of integrated nutrient management practices for yield attributes and yield on irrigated transplanted Ragi at harvest stage

	Yield attributes						
Treatments	No.of earheads m ⁻²	Number of fingers earhead	Number of grains earhead ⁻¹	Thousand grain weight (g)	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	
T1	107.16	5.31	711.12	3.02	2028	4353	
T2	115.99	8.00	817.21	3.06	2543	5300	
Т3	111.93	6.77	764.08	3.04	2281	4818	
T4	115.01	7.79	809.39	3.05	2501	5264	
T5	122.11	9.75	893.93	3.09	3097	6066	
T6	110.95	6.15	759.01	3.07	2276	4805	
T7	120.12	9.44	885.17	3.06	2990	5988	
T8	118.93	9.01	862.31	3.08	2791	5749	
Т9	119.12	9.18	871.83	3.10	2801	5862	
T10	125.01	10.66	949.14	3.11	3392	6589	
SEm±	0.80	0.23	13.96	0.09	72.98	150.64	
CD (p=0.05)	2.53	0.68	44.13	NS	216.85	447.76	

Table. 2 Effect of NPK levels, ZnSO4 and foliar fertilization on economics (Rs. ha-1) of finger millet

Treatment details	Cost of cultivation	Gross income	Net income	BCR
T1	31955	71277	39322	2.23
T2	35905	89209	53304	2.48
Т3	33555	80084	46529	2.39
T4	34755	87797	53042	2.53
T5	40305	108267	67962	2.69
T6	32722	79913	47191	2.44
T7	36672	104658	67986	2.85
T8	34322	97852	63530	2.85
T9	35522	98295	62773	2.77
T10	41072	118525	77453	2.89





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RESEARCH ARTICLE

Taylor Series Method for Solving System of Nonhomogeneous Lane-**Emden Type Equations**

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ABSTRACT

This research article introduces a numerical approach to solving systems of Lane-Emden type singular initial value problems, employing the Taylor Series Method. Through its application to these singular initial value problems, the method demonstrates significant acceleration in convergence when compared to exact solutions. Its effectiveness and straightforward implementation make it a valuable computational tool for addressing such problems. The proposed method is illustrated through several non homogeneous nonlinear systems.

Keywords: Taylor Series, Lane-Emden Equations, Numerical method, Convergence.

INTRODUCTION

In astrophysics, Lane-Emden equation is the dimensionless form of Poisson's equation. The Lane-Emden equation is a versatile mathematical tool used in theoretical physics and astrophysics, shedding light on phenomena like stellar structure, the thermal history of spherical gas clouds, isothermal gas spheres, and thermionic currents. This equation plays an important role in the fields of chemistry, physics, and astronomy [1-4]. Though the equation's singularity poses a challenge for analytical solutions, numerous methods exist for tackling singular boundary value problems [6-11]. They employed the enhanced differential transform method in [12] to derive solutions for systems of Lane-Emden type equations prevalent in diverse physical models. Utilizing Taylor series as a valuable mathematical instrument greatly aids in solving nonlinear equations. Given the significant role Taylor series play in analysis, it's





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astonishing how few endeavors have aimed at their generalization. In [13,14], the analysis of the system of homogeneous Lane-Emden type equations was conducted through the utilization of Taylor series. In this work, we applied the Taylor series method to find the solution of the system of nonhomogeneous Lane-Emden type equations. The Taylor Series Method has been elaborated upon, including examples and result analysis.

Taylor Series Method

In this paper, we consider the following system of nonhomogeneous Lane-Emden type equations,

(i)
$$u'' + \frac{\lambda_1}{r}u' + f_1(u, v) = \phi_1(x)$$
(1)

(ii)
$$v'' + \frac{\tilde{\lambda}_2}{x}v' + f_2(u,v) = \phi_2(x)$$
(2)

with initial conditions

$$u(0) = \alpha$$
; $v(0) = \beta$

$$u'(0) = 0 : v'(0) = 0$$

Multiply (1), (2) with x

$$u''x + \lambda_1 u' + x f_1(u, v) = x \phi_1(x)$$
(3)

$$v''x + \lambda_2 v' + x f_2(u, v) = x \phi_2(x)$$
(4)

Differentiate the eqn (3) with respect to x

$$u'' + u'''x + \lambda_1 u'' + f_1(u, v) + x f_1(u, v) = \phi_1(x) + x \phi_1'(x)$$
.....(5)

At x = 0

$$u'' + \lambda_1 u'' + f_1(u, v) = \phi_1(0)$$

$$u''(1 + \lambda_1) = \phi_1(0) - f_1(u, v)$$

$$u''(0) = \frac{\phi_1(0) - f_1(u, v)}{(1 + \lambda_1)}$$

Differentiate the eqn (5) with respect to x

$$2u^{(i)} + u^{iv}x + \lambda_1 u^{(i)} + f_1(u,v) + f_1(u,v) + xf_1(u,v) = 2\phi_1(x) + x\phi_1(x)$$
....(6)

$$u^{'''}(2+\lambda_1) + u^{iv}x + 2f_1'(u,v) = 2\phi_1'(x)$$
$$u^{'''}(0) = \frac{2[\phi_1' - f_1'(u,v)]}{2+\lambda_1}$$

Differentiate the eqn (6) with respect to x

$$u^{iv}(2+\lambda_1) + u^{iv} + u^{v}x + 2f_1^{"}(u,v) + xf_1^{"}(u,v) + f_1^{"}(u,v) = 3\phi_1^{"}(x) + x\phi_1^{"}(x)$$

$$u^{iv}(3+\lambda_1) + u^{v}x + 3f_1^{"}(u,v) + xf_1^{"}(u,v) = 3\phi_1^{"}(x) + x\phi_1^{"}(x)$$
....(7)

At x = 0

$$u^{iv}(3 + \lambda_1) + 3f_1^{"}(u, v) = 3\phi_1^{"}(x)$$
$$u^{iv}(0) = \frac{3[\phi_1^{"}(0) - f_1^{"}(u, v)]}{3 + \lambda_1}$$

By applying Taylor Series expansion
$$u(x) = u(0) + u'(0)\frac{x}{1!} + u''(0)\frac{x^2}{2!} + u'''(0)\frac{x^3}{3!} + u^{iv}(0)\frac{x^4}{4!} + \cdots$$

$$u(x) = \alpha + \left\{ \frac{[\phi_1(0) - f_1(u, v)]}{(1 + \lambda_1)} \right\} \frac{x^2}{2!} + \left\{ \frac{2[\phi_1' - f_1'(u, v)]}{2 + \lambda_1} \right\} \frac{x^3}{3!} + \left\{ \frac{3[\phi_1''(0) - f_1''(u, v)]}{3 + \lambda_1} \right\} \frac{x^4}{4!} + \cdots$$

$$u^{n+2}(0) = (n+1)\frac{[\phi_1^{n}(0) - f_1^{n}(u, v)]}{(n+1) + \lambda_1}$$

$$u^{n+2}(0) = (n+1) \frac{[\phi_1^n(0) - f_1^n(u,v)]}{(n+1) + \lambda_1}$$

$$u^{n}(0) = (n-1) \frac{\left[\phi_{1}^{(n-2)}(0) - f_{1}^{(n-2)}(u,v)\right]}{(n-1) + \lambda_{1}}; n = 1,2,3,4,...$$

where n is the n^{th} derivative of u.

Now, differentiate the eqn (4) with respect to x

$$v'' + v'''x + \lambda_2 v'' + f_2(u, v) + xf_2(u, v) = \phi_2(x) + x\phi_2^{(x)}$$
(8





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At x = 0

$$v'' + \lambda_2 v'' + f_2(u, v) = \phi_2(0)$$

$$v''(1 + \lambda_2) = \phi_2(0) - f_2(u, v)$$

$$v''(0) = \frac{\phi_2(0) - f_2(u, v)}{(1 + \lambda_2)}$$

Differentiate the eqn (8) with respect to x

$$2v^{\prime\prime\prime} + v^{iv}x + \lambda_2 v^{\prime\prime\prime} + 2f_2^{\prime\prime}(u, v) + xf_2^{\prime\prime}(u, v) = 2\phi_2^{\prime\prime}(x) + x\phi_2^{\prime\prime}(x) \qquad(9)$$

At x = 0

$$v^{(i)}(2+\lambda_2) + v^{iv}x + 2f_2(u,v) = 2\phi_2(x)$$
$$v^{(i)}(0) = \frac{2[\phi_2 - f_2(u,v)]}{2+\lambda_2}$$

Differentiate the eqn (9) with respect to x

$$v^{iv}(2+\lambda_2) + v^{iv} + v^{v}x + 2f_2^{"}(u,v) + xf_2^{"}(u,v) + f_2^{"}(u,v) = 3\phi_2^{"}(x) + x\phi_2^{"}(x) \dots (10)$$
$$v^{iv}(3+\lambda_2) + v^{v}x + 3f_2^{"}(u,v) + xf_2^{"}(u,v) = 3\phi_2^{"}(x) + x\phi_2^{"}(x)$$

At x = 0

$$v^{iv}(3 + \lambda_2) + 3f_2^{"}(u, v) = 3\phi_2^{"}(x)$$
$$v^{iv}(0) = \frac{3[\phi_2^{"}(0) - f_2^{"}(u, v)]}{3 + \lambda_2}$$

Hence by Taylor Series expansion
$$v(x) = v(0) + v'(0) \frac{x}{1!} + v''(0) \frac{x^2}{2!} + v'''(0) \frac{x^3}{3!} + v^{iv}(0) \frac{x^4}{4!} + \cdots$$

$$v(x) = \beta + \left\{ \frac{[\phi_2(\mathbf{0}) - f_2(\mathbf{u}, \mathbf{v})]}{(\mathbf{1} + \lambda_2)} \right\} \frac{x^2}{2!} + \left\{ \frac{2[\phi'_2 - f'_2(\mathbf{u}, \mathbf{v})]}{2 + \lambda_2} \right\} \frac{x^3}{3!} + \left\{ \frac{3[\phi''_2(\mathbf{0}) - f''_2(\mathbf{u}, \mathbf{v})]}{3 + \lambda_2} \right\} \frac{x^4}{4!} + \cdots$$

$$v^{n+2}(0) = (n+1) \frac{[\phi_2^{n}(0) - f_2^{n}(\mathbf{u}, \mathbf{v})]}{(n+1) + \lambda_2}$$

$$v^{n}(0) = (n-1)\frac{[\phi_{2}^{(n-2)}(0) - f_{2}^{(n-2)}(u,v)]}{(n-1) + \lambda_{2}}; n = 1,2,3,4,...$$

where n is the n^{th} derivative of v.

Examples

Example 1:

(i)
$$u'' + \frac{1}{x}u' - \sqrt{u^3 + v^2} = \phi_1(x)$$
 (ii) $v'' + \frac{1}{x}v' - \sqrt{u^2 + v^3} = \phi_2(x)$ (12)

Given that

$$u(0) = 2 ; v(0) = 1$$

$$u'(0) = v'(0) = 0$$

$$\phi_1(x) = 4 - \sqrt{2x^6 + 6x^4 + 12x^2 + 9 + 2x^3}$$

$$f_1(u, v) = -\sqrt{u^3 + v^2}$$

$$\lambda_1 = 1$$

Using general form

$$u^{n}(0) = (n-1)\frac{\left[\phi_{1}^{(n-2)}(0) - f_{1}^{(n-2)}(u,v)\right]}{(n-1) + \lambda_{1}}$$

If n = 1, then we get

$$u^{'}(0)=0.$$

If
$$n = 2$$
,

$$u''(0) = (1)\frac{[\phi_1(0) - f_1(u,v)]}{(1) + \lambda_1}$$
 (1)

$$\phi_1(0) = 4 - \sqrt{9} = 1$$

$$f_1(u, v) = -\sqrt{u^3(0) + v^2(0)} = -\sqrt{2^3 + 1^2} = -3$$

Substitute the values $\phi_1(0)$, $f_1(u, v)$, λ_1 in eqn 13





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$$u''(0) = \frac{1 - (-3)}{1 + 1}$$

$$u''(0) = 2.$$
If $n = 3$

$$u'''(0) = (2) \frac{\left[\phi_1'(0) - f_1'(u, v)\right]}{(2) + \lambda_1}$$

$$\phi'_1(0) = -\frac{1}{2} (2x^6 + 6x^4 + 12x^2 + 9 + 2x^3)^{-\frac{1}{2}} (12x^5 + 24x^3 + 24x + 6x^2)$$

$$\phi'_1(0) = -\frac{1}{2} \left(\frac{1}{3}\right) \times (0) = 0$$

$$f'_1(u, v) = -\frac{1}{2} (u^3 + v^2)^{-\frac{1}{2}} (3u^2u' + 2vv')$$

$$f'_1(u, v) = \left[-\frac{1}{2} \left(u^3(0) + v^2(o)\right)^{-\frac{1}{2}}\right] [3u'(0)u^2(0) + 2v(0)v'(0)] = -\frac{1}{2} (8 + 1)^{-\frac{1}{2}} [0]$$

Substitute the values $\phi'_1(0)$, $f'_1(u,v)$, λ_1 in eqn 14

$$u^{((0)} = \frac{0-0}{1+1}$$

$$u^{'''}(0) = 0.$$

If n = 4

$$\lim_{iv} = 4$$

$$u^{iv}(0) = (3) \frac{\left[\phi_{1}^{(i)}(0) - f_{1}^{(i)}(u,v)\right]}{(3) + \lambda_{1}} \qquad (15)$$

$$\phi''_{1}(x) = \frac{1}{4} (2x^{6} + 6x^{4} + 12x^{2} + 9 + 2x^{3})^{-\frac{3}{2}} (12x^{5} + 24x^{3} + 24x + 6x^{2})^{2} - \frac{1}{2} (2x^{6} + 6x^{4} + 12x^{2} + 9 + 2x^{3}) (60x^{4} + 72x^{2} + 24 + 12x)$$

$$\phi''_{1}(0) = -\frac{1}{6} (24) + \frac{1}{4} (0) = -4$$

$$f''_{1}(u,v) = -\frac{1}{2} (u^{3} + v^{2})^{-\frac{1}{2}} (3u^{2}u'' + 6uu'^{2} + 2vv'' + 2v'^{2}) + (3u^{2}u' + 2vv') (\frac{1}{4} (u^{3} + v^{2})^{-\frac{3}{2}} (3u^{2}u' + 2vv''))$$

$$f''_{1}(u,v) = \left[-\frac{1}{2}(9)^{-\frac{1}{2}} \right] [3 \times 4 \times 2] = -\frac{1}{6}(24)$$

$$f'_{1}(u,v) = -4$$
 Substitute the values $\phi''_{1}(0)$, $f''_{1}(u,v)$, λ_{1} in eqn 15

$$u^{iv}(0) = \frac{3[-4 - (-4)]}{3 + 1}$$

 $u^{iv}(0) = 0.$

Using Taylor series expansion- Maclaurin series general formula

$$u(x) = u(0) + u'(0)\frac{x}{1!} + u''(0)\frac{x^2}{2!} + u'''(0)\frac{x^3}{3!} + u^{iv}(0)\frac{x^4}{4!} + \cdots$$
$$u(x) = 2 + 2\left(\frac{x^2}{2!}\right) + 0$$
$$u(x) = 2\left(1 + \frac{x^2}{2!}\right) = 2e^x$$

and

$$v'' + \frac{1}{x}v' - \sqrt{u^2 + v^3} = \phi_2(x)$$

Given:

$$\phi_2(x) = 9x + \sqrt{x^4 + 4x^2 + 3 - x^9 - 3x^6 - 3x^3}$$

$$f_2(u, v) = \sqrt{u^2 - v^3}$$

$$\lambda_2 = 1$$

Using general form

$$v^{n}(0) = (n-1) \frac{\left[\phi_{2}^{(n-2)}(0) - f_{2}^{(n-2)}(u,v)\right]}{(n-1) + \lambda_{2}}.$$
If $n = 1$,





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$$v'(0) = 0.$$

If n = 2

$$v''(x) = (1) \frac{[\phi_2(0) - f_2(u, v)]}{(1) + \lambda_2}$$

$$\phi_2(0) = \sqrt{3}$$

$$f_2(u,v) = -\sqrt{u^2(0) - v^3(0)} = \sqrt{2^2 - 1^3} = \sqrt{3}$$

Substitute the values $\phi_2(0)$, $f_2(u, v)$, λ_2 in eqn 16

$$v''(0) = \frac{\sqrt{3} - (\sqrt{3})}{1 + 1}$$

 $v^{''}(0) = 0.$

If n = 3

$$f'_{2}(u,v) = \frac{1}{2}(u^{2}(0) - v^{3}(0))^{-\frac{1}{2}}(2u(0)u'(0) - 3v^{2}(0)v'(0))$$

$$f'_{2}(u,v) = 0$$
Substitute the values $\phi'_{2}(0)$, $f'_{2}(u,v)$, λ_{2} in eqn 17

$$v^{(\prime\prime)}(0) = \frac{2[9-0]}{2+1} = 6$$

 $v^{'''}(0) = 6.$

If n = 4

$$v^{iv}(0) = (3) \frac{[\phi_2^{"}(0) - f_2^{"}(u,v)]}{(3) + \lambda_2}$$
(18)

$$\phi''_{2}(x) = \frac{1}{2}(x^{4} + 4x^{2} + 3 - x^{9} - 3x^{6} - 3x^{3})^{-\frac{1}{2}}(12x^{2} + 8 - 72x^{7} - 90x^{4} - 18x) + ((4x^{3} + 8x - 9x^{8} - 18x^{5} - 9x^{2})(-\frac{1}{4}(x^{4} + 4x^{2} + 3 - x^{9} - 3x^{6} - 3x^{3})^{-\frac{3}{2}}(4x^{3} + 8x - 9x^{8} - 18x^{5} - 9x^{2})))$$

$$\phi''_{2}(0) = \frac{1}{2}(\frac{1}{\sqrt{3}})8 + 0 = \frac{4}{\sqrt{3}}$$

$$f''_{2}(u,v) = \frac{\frac{1}{2}[(\sqrt{u^{2}-v^{3}})(2uu'' + 2u'^{2} - 3v^{2}v'' - 6vv'^{2}) - (2uu' - 3v^{2}v')(\frac{1}{2}(u^{2} - v^{3})^{-\frac{1}{2}}(2uu' - 3v^{2}v'))]}{u^{2} - v^{3}}$$
$$f''_{2}(u,v) = \frac{1}{2}\frac{\sqrt{3}(2 \times 2 \times 2)}{3}$$
$$f'_{2}(u,v) = \frac{4}{\sqrt{3}}$$

$$f''_{2}(u,v) = \frac{1}{2} \frac{\sqrt{3}(2 \times 2 \times 2)}{3}$$
$$f'_{2}(u,v) = \frac{4}{\sqrt{2}}$$

Substitute the values $\phi''_{2}(0)$, $f''_{2}(u, v)$, λ_{2} in eqn 18

$$v^{iv}(0) = \frac{3\left[\frac{4}{\sqrt{3}} - \left(\frac{4}{\sqrt{3}}\right)\right]}{3+1}$$
$$v^{iv}(0) = 0.$$

Using Taylor series expansion- Maclaurin series general formula

$$v(x) = v(0) + v'(0)\frac{x}{1!} + v''(0)\frac{x^2}{2!} + v'''(0)\frac{x^3}{3!} + v^{iv}(0)\frac{x^4}{4!} + \cdots$$
$$v(x) = 1 + 6\left(\frac{x^3}{3!}\right) + \cdots$$
$$v(x) = 1 + x^3$$

Example 2:

(i)
$$u'' + \frac{4}{x}u' - \sin(u^2v) = \phi_1(x)$$
(19)
(ii) $v'' + \frac{3}{x}v' - \sin(uv^2) = \phi_2(x)$ (20)

(ii)
$$v'' + \frac{\hat{3}}{r}v' - \sin(uv^2) = \phi_2(x)$$
(20)





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With initial conditions

$$u(0) = v(0) = u'(0) = v'(0) = 0$$

Given:

$$\phi_1(x) = \frac{5+4x}{(1+x)^2} - \sin[(x-\ln(1+x))^2(x+\ln(1-x))]$$

$$f_1(u,v) = -\sin[u^2v)$$

$$\lambda_1 = 4$$

Using general form

$$u^{n}(0) = (n-1) \frac{\left[\phi_{1}^{(n-2)}(0) - f_{1}^{(n-2)}(u,v)\right]}{(n-1) + \lambda_{1}}$$

If n = 1

$$u'(0) = 0.$$

If
$$n = 2$$

 $u''(x) = (1) \frac{[\phi_1(0) - f_1(u, v)]}{(1) + \frac{1}{2}}$

$$\phi_1(0) = 5 - \sin 0 = 5$$

$$f_1(u, v) = -\sin(0) = 0$$

Substitute the values $\phi_1(0)$, $f_1(u, v)$, λ_1 in eqn 21

$$u''(0) = \frac{5 - (0)}{1 + 4}$$
$$u''(0) = 1.$$

If
$$n = 3$$

$$u'''(0) = (2) \frac{[\phi_1'(0) - f_1'(u,v)]}{(2) + \lambda_1}$$

$$\phi'_1(x) = \frac{4(x+1)^2 - 2(5+4x)(1+x)}{(1+x)^4}$$

$$-\{\cos[(x-\ln(1+x))^2(x+\ln(1-x))]\} \left\{ \left[(x-\ln((1+x))^2\left(1+\frac{1}{1-x}\right) \right] + \left[(x+\ln((1-x))(2)(x-\ln((1+x))\left(1-\frac{1}{1+x}\right) \right] \right\}$$

$$\phi'_1(0) = 4 - 10 - \{\cos[0] \times [0]\} = -6$$

$$f'_1(u,v) = -\cos(u^2v) \times [u^2v' + 2uu'v]$$

$$f'_1(u,v) = -\cos(u^2(0)v(0)) \times [u^2(0)v'(0) + 2u(0)u'(0)v(0)]$$

Substitute the values $\,\phi_{\,\,1}'(0),\,\,f_{\,\,1}'(u,v),\lambda_1\,\,$ in eqn 22

$$u^{(1)}(0) = \frac{2[-6-0]}{2+4}$$

$$u^{((0)} = -2.$$

If
$$n = 4$$

$$u^{iv}(x) = (3) \frac{\left[\phi_{1}^{-}(0) - f_{1}^{-}(u,v)\right]}{(3) + \lambda_{1}}$$

$$\phi''_{1}(x) = \frac{\left\{\left[(1+x)^{4}\left(8(1+x)\right) - 2 \times 4 \times (1+x) - 2(5+4x)(1)\right] - \left[4(1+x)^{2} - 2(5+4x)(1+x)\left[(4(1+x)^{3})\right]\right]\right\}}{(1+x)^{8}}$$

$$+ \left\{\sin\left[(x-\ln(1+x))^{2}(x+\ln(1-x))\right]\right\} \left\{\left[(x-\ln(1+x))^{2}\left(1+\frac{1}{1-x}\right)\right]$$

$$+ \left[(x+\ln(1-x))(2)(x-\ln(1+x))\left(1-\frac{1}{1+x}\right)\right]^{2}$$

$$-\left\{\cos\left[(x-\ln(1+x))^{2}(x+\ln(1-x))\left(1-\frac{1}{1+x}\right)\left(1-\frac{1}{1+x}\right)\left(1+\frac{1}{1-x}\right) + (x-\ln(1+x))\left(1-\frac{1}{1+x}\right) + (x-\ln(1+x))\left(1-\frac{1}{1+x}\right) + (x-\ln(1+x))\left(1-\frac{1}{1+x}\right) + (x-\ln(1-x))\left(1-\frac{1}{1+x}\right) + (x-\ln(1-x))\left$$





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$$f_{1}(u,v) = \sin[u^{2}v] \left[u^{2}v^{'} + 2uu^{'}v \right] \left[u^{2}v^{'} + 2uu^{'}v \right] - \cos[u^{2}v] \left[u^{2}v^{''} + v^{'}2uu^{'} + 2uu^{'}v + 2uu^{'}v + 2uu^{'}v + 2uu^{'}v' \right]$$

$$f_{1}(u,v) = 0$$

Substitute the values $\,\phi^{\prime\prime}_{1}(0),\,f^{\prime\prime}_{1}(u,v),\lambda_1\,$ in eqn 23

$$u^{iv}(0) = \frac{3[14]}{3+4} = 6$$
$$u^{iv}(0) = 6.$$

Hence by Taylor series, we obtain

$$u(x) = u(0) + u'(0)\frac{x}{1!} + u''(0)\frac{x^2}{2!} + u'''(0)\frac{x^3}{3!} + u^{iv}(0)\frac{x^4}{4!} + \cdots$$
$$u(x) = \frac{1}{2}x^2 - \frac{1}{3}x^3 + \frac{1}{4}x^4 - \cdots$$

Further

$$v'' + \frac{3}{x}v' - \sin(uv^2) = \phi_2(x)$$

Given that

$$\phi_2(x) = \frac{3x - 4}{(x - 1)^2} - \sin[(x - \ln(1 + x))(x + \ln(1 - x))^2]$$

$$f_2(u, v) = \cos[(uv^2)]$$

$$\lambda_2 = 3$$

Using general form

$$v^{n}(0) = (n-1)\frac{\left[\phi_{2}^{(n-2)}(0) - f_{2}^{(n-2)}(u,v)\right]}{(n-1) + \lambda_{2}}$$

If n = 1

v'(0) = 0.

If n = 2

$$v''(0) = (1) \frac{[\phi_2(0) - f_2(u,v)]}{(1) + \lambda_2}$$

$$\phi_2(0) = -4 - \sin 0 = -4$$

$$f_2(u, v) = -\sin(0) = 0$$

Substitute the values $\phi_2(0)$, $f_2(u,v)$, λ_2 in eqn 24

$$v''(0) = \frac{-4 - (0)}{1 + 3}$$
$$v''(0) = -1.$$

If n = 3

$$v^{""}(x) = (2) \frac{\left[\frac{\phi_2(0) - f_2(u, v)}{(2) + \lambda_2}\right]}{(2) + \lambda_2}$$

$$\phi'_2(x) = \frac{\left[\frac{(x - 1)^2(3) - (3x - 4)(2)(x - 1)}{(x - 1)^4}\right]}{(x - 1)^4} - \left\{\cos\left[\left(x - \ln(1 + x)\right)(x + \ln(1 - x))^2\right]\right\} \times \left\{\left[\left(x - \ln(1 + x)\right)2(x + \ln(1 - x))^2\right]\right\}$$

$$\ln 1 - x \cdot 1 - 1 - x + x + \ln 1 - x \cdot 2(1 - 11 + x)\right\}$$

$$\phi'_{2}(0) = 3 - 8 - \{\cos[0]\} \times \{[0]\} = -5$$

$$f'_{2}(u, v) = -\sin(uv^{2}) (2uvv' + u'v^{2})$$

$$f'_{2}(u, v) = -\sin(u(0)v^{2}(0)) \times [2u(0)v'(0)v(0) + u'(0)v^{2}(0)]$$

$$f'_{2}(u, v) = 0$$

Substitute the values $\phi_2'(0)$, $f_2'(u,v)$, λ_2 in eqn 25

$$v^{(\prime\prime}(0) = \frac{2[-5-0]}{2+3}$$
$$v^{(\prime\prime}(0) = -2.$$

If
$$n = 4$$

$$v^{iv}(0) = (3) \frac{\left[\phi_2^{"}(0) - f_2^{"}(u,v)\right]}{(3) + \lambda_2} \qquad (26)$$

$$\phi_2^{"}(x) = \frac{\{(x-1)^4 [3 \times 2(x-1) - 2(3x-4) - 2 \times 3(x-1)] - [(x-1)^2(3) - 2(3x-4)(x-1)](4((x-1)^3))\}}{(x-1)^8} + \left\{\sin[(x-\ln(1+x))(x+\ln(1-x))^2]\left[(x-\ln(1+x))2(x+\ln(1-x))\left(1-\frac{1}{1-x}\right) + (x+\ln(1-x))^2\left(1-\frac{1}{1+x}\right)\right]^2\right\} - \left\{\cos[(x-\ln(1+x))(x+\ln(1-x))(x+\ln(1-x))^2\right\}$$





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$$\ln(1-x))^{2} \left\{ \left[2\left(1 - \frac{1}{1+x}\right)(x + \ln(1-x))\left(1 - \frac{1}{1-x}\right) + 2(x - \ln(1+x))(1 + \frac{1}{1-x})(1 - \frac{1}{1-x}) + 2(x - \ln(1+x))(1 + \frac{1}{1-x})(1 - \frac{1}{1-x}) + 2(x - \ln(1+x))(x + \ln(1-x))\left(\frac{1}{(1-x)^{2}}\right)(-1) \right] + \left[\left(2(x + \ln(1-x))\left(1 + \frac{1}{1-x}\right)(-1)\left(1 - \frac{1}{1+x}\right) \right) + (x + \ln(1-x))^{2} \left(-\frac{1}{(1+x)^{2}} \right) \right] \right\}$$

$$\phi''_{2}(0) = \left\{ 1\left[3 \times 2 \times (-1) - 2 \times (-4) - 2 \times 3 \times (-1) \right] - \left[3 - 2 \times (-4) \times (-1) \right] \times 4 \times \right.$$

$$\phi''_{2}(0) = -6 + 8 + 6 - \left[(3 - 8)(-4) \right] = 8 - 20$$

$$\phi''_{2}(0) = -12$$

$$f''_{2}(u,v) = \left\{ \left[-\cos(uv^{2}) \right] \left[2uvv' + v^{2}u' \right]^{2} + \left[-\sin(uv^{2}) \right] \left[\left(2uvv'' + 2uv'^{2} + 2u'vv' \right) + \left(v^{2}u'' + 2vv'u' \right) \right] \right\}$$

$$f''_{2}(u,v) = 0$$
Substitute the values $\phi''_{2}(0)$, $f''_{2}(u,v)$, λ_{2} in eqn 26
$$v^{iv}(0) = \frac{3[-12]}{2} = -6$$

$$v^{iv}(0) = \frac{3[-12]}{3+3} = -6$$

 $v^{iv}(0) = -6.$

Hence by Taylor series, we get

$$v(x) = v(0) + v'(0)\frac{x}{1!} + v''(0)\frac{x^2}{2!} + v'''(0)\frac{x^3}{3!} + v^{iv}(0)\frac{x^4}{4!} + \cdots$$
$$v(x) = -\frac{1}{2}x^2 - \frac{1}{3}x^3 - \frac{1}{4}x^4 - \cdots$$

CONCLUSION

The Taylor series method stands out among other analytical approaches for its streamlined solution process and precise outcomes. What distinguishes it is the skillful avoidance of superfluous terms, ensuring convergence to the exact solution is an edge that sets it apart.

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RESEARCH ARTICLE

Comparative Proximate Analysis of Indian Ragi Food Supplements

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ABSTRACT

Ragi is high in fiber, carbs, protein, calcium, and iron. Ragi has calcium, which helps to build stronger teeth and bones. Ragi aids in anemia healing. Ragi helps diabetic patients by stabilizing blood sugar levels. Its protein and fiber levels aid in controlling weight. An invaluable resource for learning about food products' nutritional composition is proximate analysis. Any water present in a food product is considered to be part of its moisture content. A number of factors, including ambient moisture from the production and packing sites, packaging techniques, and ragi storage, can cause excess moisture to enter the product. The minerals and inorganics that remain after the Ragi sample has been burned to an extremely high temperature, eliminating moisture, volatiles, and organics, are referred to as the ash content of Ragi. The results of the present study confirmed that the selected food supplements of ragi were rich in proximate component but lower than the raw ragi millet. This may be due to the addition of food additives in order to maintain the structure and taste of the food supplements.

Keywords: Ragi, proximate composition.





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INTRODUCTION

In many parts of Africa and India, ragi is a traditional dish. Eleusine coracana is its scientific name. In India, Karnataka is where ragi is primarily farmed and eaten, with smaller amounts being found in Andhra Pradesh, Tamilnadu, Odisha, Maharashtra, Uttarakhand, and Goa. Another name for ragi is Finger Millet. Its advantages in nutrition Ragi is a fantastic option for a variety of recipes because it has a distinct flavor and texture. Ragi is high in fiber, carbs, protein, calcium, and iron. Ragi has calcium, which helps to build stronger teeth and bones. Ragi aids in anemia healing. Ragi helps diabetic patients by stabilizing blood sugar levels. Its protein and fiber levels aid in controlling weight. Consuming too much ragi might raise the amount of oxalic acid in human. Ragi is high in antioxidants, which help the body quickly remove harmful free radicals from the body, especially from the liver and gallbladder. In this way, the body's tridoshic states are blanched, and all unwanted fatty deposits are removed, preserving ideal liver function. Anxiety, depression, and dandruff can all be managed with ragi. Ragi's phenolic content lowers the chance of developing cancer. Consuming ragi lowers childhood asthma risk by almost fifty percent. Because of its toxin-reducing properties, ragi is beneficial for controlling cholesterol, according to Ayurveda. Because ragi is an excellent source of iron, people with low hemoglobin levels can benefit from eating it.

An invaluable resource for learning about food products' nutritional composition is proximate analysis. Any water present in a food product is considered to be part of its moisture content. A number of factors, including ambient moisture from the production and packing sites, packaging techniques, and ragi storage, can cause excess moisture to enter the product. The minerals and inorganics that remain after the Ragi sample has been burned to an extremely high temperature, eliminating moisture, volatiles, and organics, are referred to as the ash content of Ragi. Through controlling body protein synthesis and lean body mass, which is mostly made up of organs, red muscle, and white muscle, the protein content and amino acid composition of the diet affects the growth of animals. Carbs, or the amount of carbohydrates in a food or beverage, are a class of macronutrient. Carbohydrates include fiber, sugars, and starches. The macronutrients fat and protein are further examples. To maintain health, your body requires certain macronutrients. Through controlling body protein synthesis and lean body mass, which is mostly made up of organs, red muscle, and white muscle, the protein content and amino acid composition of the diet affects the growth of animals. Carbs, or the amount of carbohydrates in a food or beverage, are a class of macronutrient. Carbohydrates include fiber, sugars, and starches. The macronutrients fat and protein are further examples. To maintain health, your body requires certain macronutrients. The objectives of this study are to, compare the proximate composition of ragi food supplements with raw ragi millet and analyze the proximate composition of a few Indian ragi food supplements.

METHODOLOGY

COLLECTION OF SAMPLES AND PREPARATION

The raw ragi millet and the brands of ragi vermicelli like, Anil, Suraya, and Ramar were purchased from stores which are used wisely by local people. Powders were made from the samples. After that, the powders were used for additional analysis.

DETERMINATION OF PROXIMATE COMPOSITION:

Standard methods were used to determine the moisture, Ash, crude fat, crude fibre, and crude protein and carbohydrate contents of each sample, all of which were carried out in triplicate. Moisture content was determined by heating 2.0 g of each fresh sample to a constant weight in a crucible placed in an oven maintained at 105 0C. The ash content was determined by theincineration of 5 g samples placed in a muffle furnace maintained at 550 0C for 5 - 8 hrs. The crude protein was determined by lowery method, using 0.5 g of samples. The lipid content was determined water bath method. Each analysis was carried out in triplicates. The carbohydrate content was determined by the difference i.e. deducing the sum of the percentage (moisture, ash, fibre, fat, and protein) from 100.





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RESULT

From this study the moisture content of Suriya ragi vermicelli (13%) and Ramar ragi vermicelli (10.5%) has high moisture content and Anil vermicelli(9%) has lower moisture content compared to raw ragi millet (10%)(Fig:1). From this study the Ash content of Ramar ragi vermicelli(26.6%), Suriya ragi (11.4%) vermicelli and Anil vermicelli(14.6%) has high Ash content compared to raw ragi millet (13.4%)(Fig:2). From this study the lipid content of Ramar ragi vermicelli (3%) and Suriya ragi vermicelli (1.5%) has high lipid content and Anil ragi vermicelli (1%) has same lipid content compared to raw ragi millet (1%)(Fig:3). From this study the protein content of Anil ragi vermicelli is high (O.4%) and Ramar ragi vermicelli(0.2%) and Suriya ragi vermicelli (0.2%) has same protein content compared to raw ragi millet (0.2%)(Fig:4). From this study the carbohydrate content of Ramar ragi vermicelli (59.6%), Suriya ragi vermicelli (73.7%), and Anil ragi vermicelli (74.9%) has low carbohydrate content compared to raw ragi millet (75.1) (Fig:5) (Table :1)

DISCUSSION

In the present study proximate composition (%) of selected ragi food supplement were estimated and compared with the proximate composition(%) of raw ragi millet. From this study the high moisture content is observed in Suriya ragi vermicelli compared to Ramar ragi vermicelli, Anil ragi vermicelli, raw ragi millet. The high moisture is observed in B.mannii seed compared to C.racemosum leaves(Akint and Bhosle, 2020). From this study the high Ash content is observed in Ramar ragi vermicelli compared to Suriya ragi vermicelli, Anil ragi vermicelli, raw ragi millet. The high Ash content is observed in Terminalia catappa endocarp flour compared to Terminalia catappa seed (Anuforoet al., 2017). From this study the high lipid content is observed in Ramar ragi vermicelli compared to Suriya ragi vermicelli, raw ragi millet. The high lipid content is observed in Moringa oleifera seeds compared to soya beans (Okolo et al., 2012). Form this study the high protein content is observed in Anil ragi vermicelli compared to Suriya ragi vermicelli, Ramar ragi vermicelli, raw ragi millet. The high protein content is observed in ragi compared to ragi based halwa mix(Goswamiet al., 2016). From this study the high carbohydrate content is observed in raw ragi millet vermicelli compared to Ramar ragi vermicelli, Suriya ragi vermicelli, Anil ragi. The high carbohydrate content is observed in Brassica oleraceae var. capitate compared to Amaranthus caudatusleaves(Khan etal., 2013).

CONCLUSION

In conclusion, the selected ragi food supplements were shown to be rich in moisture, ash, and lipid component and were shown to be low in protein and carbohydrate when compared to the ragi millet. The results of the present study confirmed that the selected food supplements of ragi were rich in proximate component but lower than the raw ragi millet. This may be due to the addition of food additives in order to maintain the structure and taste of the food supplements.

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Table 1: Proximate Composition(%) of selected ragi vermicelli and ragi millet

S.No	Samples	Moisture	Ash	Protein	Lipid	Carbohydrate
	1	content	content	content	content	content
1	Ramar ragi vermicelli	10.49±0.04	26.13±0.23	0.38±0.01	0.05±0.00	59.47±0.13
2	Suriya ragi vermicelli	12.77±0.14	11.3±0.05	0.38±0.01	0.03±0.00	73.6±0.12
3	Anil ragi vermicelli	8.93±0.08	14.3±0.17	0.48±0.01	0.02±0.00	74.67±0.12
4	Raw ragi millet	10.15±0.32	13.17±0.14	0.52±0.00	0.02±0.00	75.13±0.03

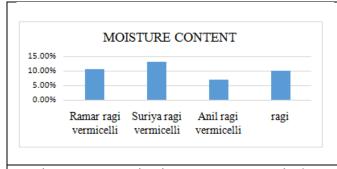


Fig 1: Percentage of moisture content present in the selected ragi food supplements

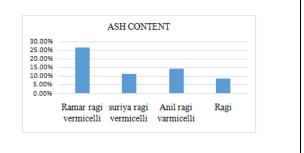
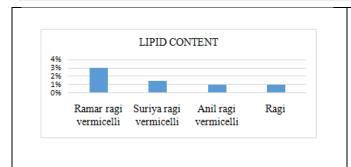


Fig 2: Percentage of ash content present in the selected ragi food supplement





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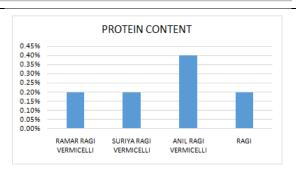


Fig 3: Percentage of lipid content present in the selected ragi food supplement

Fig 4: Percentage of protein content present in the selected ragi food supplement

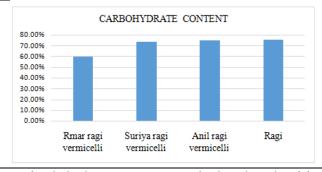


Fig 5: Percentage of carbohydrate content present in the selected ragi food supplements





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RESEARCH ARTICLE

Comprehensive Approach Chronic to Musculoskeletal Pain Management: Integrating Biopsychosocial Principles in Physiotherapy **Practice**

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ABSTRACT

Chronic musculoskeletal pain management necessitates transformative, multimodal physiotherapy interventions to enhance patient care. The International Classification of Diseases (ICD-11) distinguishes primary and secondary pain types, influenced by diverse risk factors including demographic, lifestyle, and psychosocial elements. Central sensitization plays a crucial role in chronicity, intertwining neurophysiological and psychosocial factors. Traditional therapies like exercise and education exhibit variable efficacy, prompting a shift towards a biopsychosocial model. Pain neuroscience education (PNE) gains traction, emphasizing pain mechanisms and interactions. Biopsychosocial assessments guide tailored treatments, while diverse pain assessment tools aid clinical evaluation. Behavioural interventions promote sustainable patient behaviour change, and self-management programs offer promise contingent on engagement. Multidisciplinary pain clinics provide comprehensive care, addressing unhelpful beliefs. Education is crucial to align biomedical and biopsychosocial perspectives among healthcare providers. Embracing a biopsychosocial model enhances chronic pain management, emphasizing patient empowerment and collaborative care for improved outcomes.





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Keywords: Chronic Musculoskeletal Pain, Biopsychosocial Model, Self-Management, Pain Assessment, Pain Management

INTRODUCTION

The International Classification of Diseases(ICD-11) classification offers a new approach to chronic musculoskeletal pain, dividing it into primary and secondary pain types. Primary pain is not caused by a specific disease, while secondary pain is a symptom of an underlying disease. The classification aims to improve pain management and research through accurate analysis. (1-3). The risk factors for developing chronic pain include age and sex, smoking, drinking, less education, less physical activity, less control, less social interaction, less family income, depression, anxiety and insomnia, physical activity, and separated or divorced (4-6) Factors like low self-esteem, physical symptoms, and negative beliefs can influence musculoskeletal pain. Additionally, social beliefs play a role in how pain is perceived and eliminated. Psychological aspects related to work, such as job demands, control levels, support received, satisfaction with work, effort-reward balance, and the monotony of tasks, can also impact musculoskeletal pain. Individuals experiencing musculoskeletal pain along with low mood may find therapy beneficial. (7, 8) Central sensitisation (CS) refers to heightened nervous system sensitivity, leading to an increased perception of pain. It manifests as generalized hypersensitivity and amplified temporal summation of pain signals, contributing to the persistence of musculoskeletal pain pathology. CS is closely linked with psychosocial and cognitive behavioural factors, indicating that psychological and social elements play significant roles in the development and perpetuation of chronic musculoskeletal pain.(9-17). With increased sensitization of the central nervous system and decreased functioning of the nervous system to perform or regulate descending pain inhibition which may lead to phenomena like allodynia and hyperalgesia in chronic Musculoskeletal conditions, subsequently limiting physical, mental and functional ability and capacity of individuals. (18, 19)It is imperative to identify patients with centrally sensitized pain in clinical practice to prevent adverse outcomes during physiotherapeutic interventions.

Application of therapeutic measures without considering central sensitization may exacerbate the condition. Understanding the biopsychosocial factors contributing to central sensitization is crucial for effectively managing patients within this subgroup(17) Statistical analyses, such as hierarchical regression, have shown that biopsychosocial factors significantly contribute to the variance of central sensitization in patients with chronic musculoskeletal shoulder pain. In a sample of 200 patients with chronic musculoskeletal pain, 39 individuals exhibited Central Sensitization Inventory (CSI) scores above 40, indicating that approximately 19.5% of patients were affected by central sensitization. This suggests that a considerable proportion, roughly 1 in 5 individuals with any musculoskeletal pain, may be susceptible to central sensitization. Lethem et al. introduced the 'fear-avoidance' model to elucidate the chronic pain process. The central tenet of this model is the fear of pain, which, unfortunately, perpetuates or intensifies fear, contributing to the development of chronic issues in many individuals experiencing muscle pain. Consequently, there is an increased focus on dysfunction and vulnerability within this population, emphasizing the need for comprehensive management strategies that address both physical and psychological components of pain. (20-22) Beliefs and expectations regarding pain play a significant role in the experience of difficult muscle pain and have been recognized as contributing factors to disability. However, there is potential to address and mitigate these characteristics in the future, suggesting the possibility of interventions aimed at modifying beliefs and expectations surrounding pain. (23-25). Pain syndrome often induces negative mental and emotional states, heightening awareness of weakness and exacerbating associated symptoms. It is considered a psychological issue due to its profound impact on emotional well-being and cognitive functioning. Moreover, the biological effects of pain have been observed to adversely affect various physiological systems, including the neuromuscular, cardiovascular, immune, and neuroendocrine systems. These findings underscore the complex interplay between psychological and physiological factors in the manifestation and perpetuation of pain syndromes. Addressing both the psychological and physiological aspects of pain is essential for comprehensive pain management and improving overall well-being. (26, 27).





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PHYSIOTHERAPY PRACTICE IN CHRONIC PAIN MANAGEMENT

In general, CMP treatment includes exercise therapy, transcutaneous electrical nerve stimulation (TENS), ultrasound and laser therapy, patient education and counselling, massage, circulation, lumbar support, and massage therapy. hot Cold. used method Compared with conventional treatment, exercise therapy improves pain relief, disability, and organ function after treatment. Behavioural treatment was shown to be effective in reducing pain in the short follow-up period compared to no-treatment/wait-list controls. Various treatments have been shown to reduce pain and short-term disability compared to no treatment. Exercise therapy and behaviour therapy have low-quality evidence for effectiveness. Multimodal treatment is effective, but there is currently no effective treatment for reducing pain in the short term for low back pain (LBP). Due to diverse populations, interventions, and comparison groups, there is insufficient data to draw firm conclusions on the clinical effect of various treatments for chronic LBP(28) By definition chronic pain cannot be treated and cured in the conventional biomedical sense; rather, the patient who is suffering from the pain must be given the tools with which their long-term pain can be managed to an acceptable level. The pain clinic offers a biopsychosocial approach to treatment with a multidisciplinary pain management programme; encouraging patients to take control of their pain problem and lead a fulfilling life despite the pain (29).

The introduction of the bio-psychosocial model of pain during the past decade stimulated the development of more therapeutically effective and cost-effective interdisciplinary chronic pain management programs. Pain neuroscience education (PNE) is increasingly vital in physical therapy for chronic pain. Before administering PNE, clinicians conduct a thorough assessment to identify the dominant pain mechanism and assess biopsychosocial factors. This helps tailor treatment plans, including PNE, to individual patients, addressing both physical and psychosocial aspects of pain for better outcomes.(30-32)To gain a deeper insight into the factors influencing doctors' approaches to treating chronic pain, it is essential to comprehend the clinical decision-making processes and the various factors that shape their application. The core categories guiding the application of a biopsychosocial approach include general practitioner (GP) attitudes, cost considerations, GP knowledge levels, time constraints, the quality of the patientdoctor relationship, and biomedical factors. These elements collectively influence the treatment decisions made by healthcare providers and impact the effectiveness of chronic pain management strategies. In the context of chronic musculoskeletal pain (CMP), clinicians are encouraged to personalize exercise plans tailored to the individual needs of patients. This personalized approach helps to avoid the inadvertent association of physical activity with pain, thereby promoting adherence to exercise regimens and facilitating better outcomes in pain management. Fortunately, evidence-based guidelines are readily available for prescribing exercises specifically tailored to address CMP. By adhering to these guidelines, clinicians can ensure that exercise prescriptions are grounded in scientific research and tailored to the unique needs and limitations of each patient, thereby optimizing the therapeutic benefits of physical activity in managing chronic musculoskeletal pain.(33-35).

BIOPSYCHOSOCIAL ASSESSMENT APPROACH

Chronic musculoskeletal pain affects quality of life and can lead to sleep disruption, fatigue, and depression. To assess pain accurately, a comprehensive bio-psychosocial approach is necessary. This approach should include patient-report questionnaires and physical examination to determine the appropriate treatment. As part of the bio-psychosocial assessment, it is essential to consider occupational changes and the impact of previous treatments. This approach helps to identify patients with severe pain and vulnerable groups such as the elderly and disabled (36,37) Given the complex and often persistent nature of chronic musculoskeletal pain, the focus on improving pain-related disability emerges as a crucial objective for certain patients, surpassing mere pain control. Consequently, the utilization of disability-related metrics within quality-of-life assessments becomes particularly pertinent. These metrics offer a comprehensive evaluation of the impact of chronic pain on various aspects of daily functioning and overall well-being. Multi-dimensional scores, as opposed to unidimensional ones, offer a more holistic assessment of pain and its associated symptoms. These scores encompass a range of dimensions including sleep disturbance, mood alterations, changes in appetite, alterations in behaviour, and other related activities. By considering these diverse dimensions, clinicians gain a deeper understanding of the multifaceted impact of chronic musculoskeletal pain on patients' lives. (38-40) A plethora of pain assessment tools is available to researchers conducting clinical trials, each designed to capture specific facets of pain experience and its related effects. These tools range from simple visual





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assessment scale (VAS) questionnaires to more comprehensive checklists and inventories. Some commonly used assessments include: Pressure pain threshold (PPT), the Fear-Avoidance Components Scale (FACS), the Depression scale(PHQ-9), the Central sensitization inventory (CSI), the Numerical pain rating scale (NPRS), Shoulder pain and disability index(SPADI), The Roland-Morris Disability Questionnaire(RMDQ), Oswestry Low Back Pain Disability Index(ODI), Neck Disability Index (NDI), Tampa Scale of Kinesio phobia (TSK), Kessler Psychological Distress Scale (K10), The Fatigue Severity Scale (FSS), widespread pain index (WPI) and "symptom severity (SS) scale, Pain catastrophizing scale(PCS) and Insomnia Severity Index (ISI) Assessments can provide valuable insights into chronic musculoskeletal pain. Combining these tools can help develop targeted interventions to improve patients' overall outcomes. (41-67)

CHRONIC MUSCULOSKELETAL PAIN MANAGEMENT

Physiotherapy treatment choices for chronic musculoskeletal pain (CMP) are often not based on existing research evidence. A behavioural modification approach in physiotherapy can initiate and maintain clinical behaviour change. However, the lack of self-management capability, intrinsic motivation, and continued support may lead to the failure of the behavioural change over time. Pain education knowledge material, personalized goal-setting, and learning from peers are useful facilitation methods to achieve clinical behaviour change. An action design of process evaluations is needed to initiate and maintain clinical behaviour change in CMP management.(68,69) One study found that patients' perception of treatment helpfulness was influenced by sociodemographic factors, and it affected the degree of pain relief. Inconclusive evidence was found for the effectiveness of pain management programs and social interventions for chronic pain. A committee recommended psychological therapy but lacked evidence to support manual therapy and electrical physical modalities. Psychophysiologic symptom relief therapy is a feasible option for nonspecific back pain treatment, according to the draft 2020 NICE guideline (70-72) Biomedical techniques have failed to control the increasing healthcare costs and disability caused by chronic low back pain. And related health messages only focus on the spine's vulnerability, ignoring the multiple factors that contribute to pain and disability. Cognitive functional therapy is a flexible integrated approach that targets chronic low back pain management by combining behavioural psychology and neuroscience within physical therapy.(73) Self-management is key to preventing long-term disability from musculoskeletal disorders. It involves adapting and managing oneself in the face of challenges and encompasses managing symptoms, treatment, and lifestyle changes (74, 75) Selfmanagement programs have potential for patients with chronic musculoskeletal pain.

However, their effectiveness varies with intervention content, and provides marginal short-term benefits for physical function and pain intensity, and long-term benefits for self-efficacy. (76, 77) In practice the patients viewed self-care positively and as an individually-adjusted and effective treatment. Healthcare providers saw self-care as a complementary treatment with short-lived effects(78) Physical therapists should use a self-management approach, targeting individual characteristics of patients with persistent musculoskeletal disorders. It should encourage an active lifestyle, behavioural changes, and a patient-provider partnership. This approach involves problem-solving, decision-making, and self-monitoring to provide effective treatment (74, 79)To manage chronic musculoskeletal pain, healthcare providers should use a biopsychosocial approach. This involves understanding the biological, psychological, and social/environmental factors that contribute to pain. Referring patients to multidisciplinary pain clinics is recommended in cases of serious medical conditions or treatment problems. Addressing unhelpful beliefs is the first step in treating patients with muscle pain, according to clinical guidelines. Changing negative beliefs, behaviours, and illnesses can help improve their condition (80,81) Changes in health care and the work of physicians are not difficult for individual physicians, but they require administrative support for the clinical setting and the health system. Although there is currently no clear evidence showing the best way to support low back pain selfmanagement in clinical practice, key factors related to pain-related cognitive processes, behaviour and patient autonomy have been identified (82) However, biomedical and biopsychosocial beliefs differ among physical therapists. (83) Healthcare providers' beliefs and attitudes influence low back pain (LBP) disability and recommendations to patients. The biologically oriented nature of university education increases negative beliefs and attitudes about LBP, whereas education following a biopsychosocial model reduces these negative beliefs in health professionals. (84) Current models of pain management do not offer the necessary comprehensive approach. Most





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patients with chronic pain are managed by primary care physicians who are not well-equipped to manage these cases effectively. A biopsychosocial approach to the assessment and treatment of chronic pain has clinical and economic implications (85)

CONCLUSION

The current need in chronic musculoskeletal pain management is for physiotherapy treatment protocols that are transformative, multimodal, or multi-dimensional. Among these modalities, it is important to prioritize physiotherapists themselves as superior providers of therapy sessions in the clinical setting.

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RESEARCH ARTICLE

Genre Classification of English and Tamil Songs using CNN

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ABSTRACT

Enormous volume of multimedia data is generated and stored online in recent times. This increase in the amount of audio data makes information retrieval a challenging task. This can be addressed through organizing the audio files by analyzing and classifying it based on artist, album, genre etc. Classification of music into various genres helps in recommending songs and artists who have worked on the desired genre of music. Manual classification of large amount of data is generally time consuming and very subjective in nature leading to ambiguity issue. Western music can be predominantly classified as Rock, Blues, Classical, Metal, Pop, Jazz, Hip Hop, Reggae, Disco and country class, while Tamil cinema songs mostly falls under Carnatic, Melody and fast beat (Kuthu) songs. Traditional music genre classification techniques should have prior knowledge to extract certain music signal characteristics like ZCR, Pitch, Rhythmic Content, MFCC, Timbral features etc. In the case of the conventional methods, no prior knowledge about music signal processing is essential to extract relevant features from the signal for the classification task. In this project we have used Convolutional Neural Networks (CNN) which performs deep learning to carry out the genre classification. Recent experiments in the literature show that CNN has a strong capacity to capture informative features from the variations of musical patterns with minimal prior knowledge provided. The proposed system was trained and tested for western music using the GTZAN dataset which contains songs of 10 different genres and gives a performance accuracy of 93.4%. Tamil cinema songs were trained and tested using songs collected from various websites and music sources and gives a performance of 95.2%.





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Keywords: Genre, Tamil Songs, Patterns, Pitch, Convolutional Neural Networks.

INTRODUCTION

Mel-spectrogram is provided as an input for the proposed model (Fig 1). Each audio in the database is of 30 seconds length. These are split into chunks of 3 seconds with 50% overlap. This gives 19 audio chunks for each audio making a total of 1,900 samples for each genre. The audios are sampled at a rate of 22050 samples/second. Each audio chunk is taken up and a fast fourier transform (FFT) over short span ie. short time fourier transform (STFT) is computed on the same to convert it to the frequency domain. This fast fourier transform is performed with a hanning window of size 2048 with hop length or overlap of 512. The spectrogram is obtained by mapping amplitude with frequency for each frame after FFT and combining them. Since only a limited frequency range is preceived by humans , the magnitude of the spectrogram is converted to the log scale in Decibels. The mel scale partitions the frequency spectrum into evenly spaced bins such that perceptually similar pitch intervals appear equal in width over the full hearing range. In this work 128 mel bins have been used to create the mel scale or the mel filter. The power spectrogram is obtained by raising the the magnitude spectrogram to power of 2. The mel-spectrogam is a dot product of the power spectrogram and the mel filter. The above tasks are performed by using Librosa. The resulting mel-spectrogram is saved as images of different dimensions of 64x64, 224x224, 300x300, 400x400 pixels. The details are summarized in Table 1. In this work a Convolutional Neural Network (CNN) has been utilized for music genre classification. The convolutional neural network has one input layer, 6 hidden layers of which 5 are convolution and one is fully connected and one output layer (Fig 2). The input image of varied dimensions are input into the model. The input layer is a 2d Convolution layer of dimension (3 x 3) with 32 filters. The convolution operation in the 2d Convolution layer is performed with a stride of 1 and padded with number on the edge. The input layer is followed by a max pooling layer of dimension (2 x 2). A dropout of 25% is introduced to avoid overfitting. This is followed by 2 hidden 2d Convolution layers of dimension (3 x 3) with 64 filters and a (2 x 2) max pooling layer. Again a 25% dropout is introduced. This is followed by 3 2d Convolution layers of dimension (3 x 3) with 128 filters each and a (2 x 2) max pooling layer with a 25% dropout. The model is then flattended and a fully connected layer of 512 nodes is added. A dropout of 50% is introduced this time. ReLU is used as the activation function in all the above steps. The last layer or the output layer is a fully connected layer with 10 nodes corresponding to the 10 genres and uses Softmax as the activation function. The specifications are summerized in (Table 2).

EXPERIMENT AND RESULT:

TRAINING DETAILS

The CNN model for this work is built using Python and trained and tested in Azure cloud platform. A Data Science virtual machine NC6 with NVIDIA GPU, 6 vcpus and 56 GB memory is used for the execution. The input audio from the database is pre-processed and converted into mel-spectrograms. After the pre processing stage each class has 1900 mel-spectrograms. These are randomly split into testing and training data. The test-train split is varied each time and it is either 70-30, 80-20 or 90-10. The training images are optionally augmented with rotation, width shift, height, sheer, zoom, and horizontal flip and performance is analysed with and without this augmentation. The model is trained with a batch size of 32 and learning rate of 0.01. The number of epochs is varied each time and is either 40 or 75 or 100. Stochastic Gradient Descent (SGD) optimiser is used for learning control. Optimizer is used to minimize the loss function. Categorical crossentropy is used as the loss function to minimise, since the model is a multiclass classifier. Accuracy is used as the metric to evaluate the model. The training details are summarized in (Table 3).





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EVALULATION AND DISCUSSION

COMPARISON ACROSS DIFFERENT CHUNK DURATION

During the preprocessing stage the first step is to split the audio into smaller chunks. Experiment is carried out by varying this chunk duration in the very first step. Three different chunk durations 2,3 and 5 seconds are chosen for the comparison. The pre-processing and model training are done and the models are compared based on the resultant accuracy. The training is with Mel-spectrogram images of size 64x64 pixels and train test split of 90%-10%. The accuracy of 2 second chunk model is 62% and 5 second chunk is 52% while the 3 second chunk gives an output of 90%. It is concluded that the 3 second chunks give a better performance when compared to the 2 second and 5 second chunks (Table 4).

COMPARISON ACROSS DIFFERENT NUMBER OF EPOCHS

Epochs define the number of times the entire training set passes through the neural network. The model is trained with varying number of epochs each time to determine its effect on the performance. Mel-spectrograms of dimension 64x64 px generated using 3 second chunk audio is input to the model and is trained for 40 epochs and 75 epochs. It is observed that there has been a considerable raise in the accuracy when the epoch is increased from 40 to 75. The model trained with 75 epochs gives an accuracy of 63% while the one trained with 40 epochs gives 57%. It is also observed that there is not much raise in accuracy when the epoch is increased from 75 to 100. The accuracy for image size of 300x300 for 3 second chunk for 75 epochs is 69.3% while it is 70.0% for 100 epochs (Table 4).

COMPARISON ACROSS DIFFERENT IMAGE SIZE

The model is trained with Mel-spectrogram images of sizes 64x64, 224x224, 300x300 and 400x400 pixels. It is observed that the accuracy is highest for image size of 300x300 px. The image size 64x64 gives an accuracy of 57%, 224x224 gives an accuracy of 67%, the image size of 400x400 gives an accuracy of 43% and the dimension 300x300 give an accuracy of 70%. The considerable decrease in the accuracy for higher dimension of image could attributed to wide distribution of the characteristics and the inability of the model to capture the features from the larger dimension. In all the above comparisons the images are augmented with with rotation, width shift , height , sheer , zoom and horizontal flip. The augmentation step is skipped and the model is trained with just the Mel-spectrograms. That dimension of 64x64 px gives accuracy as high as 93.4% without augmentation. It is observed that the augmentation step is detrimental to the learning in this case. After a series of experiments and comparisons the final set of parameters which are found to produce good results are concluded. Chunks of 3 second duration is pre-processed to produce Mel-spectrograms of dimension $64 \times 64 \text{ px}$. The model is trained with 75 epochs without augmentation, with a train – test split of 80 - 20. An accuracy of 93.4% is obtained.

PERFORMANCE OF TAMIL CINEMA MUSIC MODEL

The Tamil cinema music model used the same training parameter values as the GTZAN model used. Once the parameters were experimented and fixed, they were used as such for the Tamil cinema model. The total number of samples in the Tamil cinema music set was 5250, 1750 for each class. A train test split of 80%- 20% was used, and the epoch was fixed at 40. The model gave an accuracy of 95.2%.

TESTING TAMIL CINEMA MUSIC MODEL AGAINST EXTERNAL SONGS

The Tamil songs model was tested against 60 external songs, 20 songs in each class. A label is predicted for every 3 second chunk of the song and the label with the maximum occurrence is gives as the final genre of the song. The model classified 58/60 songs correctly giving an accuracy of 96.66%.





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CONCLUSION AND FUTURE WORK

In this project we present a methodology to automatically classify music into different genres. A CNN model is built using the information from the spectrogram images generated from the music signals of a western music dataset, GTZAN. The process of feature extraction which requires prior knowledge regarding the music signals is excluded from this work. Our experiments show that CNN is a viable alternative for feature extraction-based approach. We presented a comparison on the various accuracies obtained by using different combinations of hyper parameter sets, chunking duration and image size. Our final model was built based on the set of hyper-parameters and other factors that gave optimal accuracy. We further went on to train the model with the Tamil cinema songs dataset with similar factors. The Tamil model has also reached the desired outcome and predicts the genre of Tamil cinema songs. Our experiments reveal that our current model is not robust enough to categorize unseen musical data. Enlarging the dataset with more relevant songs can be considered as a solution to the above stated problem. Further applications of image processing techniques are likely to produce fruitful results towards music classification. The aim of the project ultimately is to predict the genre of the given song with utmost accuracy.

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Table 1. Pre-processing details

Audio chunk length	3 seconds		
Audio chunk overlap	1.5 seconds		
Sampling rate	22050		
FFT window size	2048		
FFT hop size	512		
Mel Bins	128		
Image size	64x64, 224x224, 300x300, 400x400 pixels		

Table 2. Model hyper-parameters

Number of filters	32, 64, 128
Size of filter	3x3
Max Pooling Shape	2x2
Stride	1
Padding	Number on the edge
Activation Function	Relu, Softmax
Hidden layers	6
Dropout	0.25, 0.5

Table 3. Training details

Test-train split	70-30, 80-20, 90-10
Batch size	32
Learning rate	0.01
Number or epochs	40 / 75 / 100
Optimizer	SGD
Loss function	Categorical cross entropy
Metric	Accuracy





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Table 4. Performance comparison

Chunks Duration (Seconds)	Image size (Height * Width)	Number of Epochs	Test-Train split (%)	Accuracy
5 Second Chunks	64*64	75	90-10	52.06%
	300 * 300	75	90-10	69.37%
	300 300	100	90-10	70.0%
		40	90-10	57.01%
	64*64	40	80-20	49.90%
3 Second Chunks		75	90-10	93.94% (without
5 Second Charks				augmentation)
			80-20	93.42% (without
				augmentation)
			70-30	89.14% (without
				augmentation)
	400*400	75	90-10	43.54%
	224 * 224	100	90-10	67.11%
2 Second Chunks	64*64	75	90-10	62.54%





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RESEARCH ARTICLE

An Economic Analysis of Contract Farming of Cotton Seed Cultivation in Tamil Nadu

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ABSTRACT

Cotton is the world's leading fiber. It's commonly referred to as White gold and is an industrial commodity of global significance. Contract farming refers to a company lending "inputs" such as seeds, fertilizers, credits or extensions to a farmer in return for exclusive purchasing rights for a given crop. The purpose of this study is to (1) analyze the cost of cultivation for cotton seed production based on GMS and Conventional method of contract farming and (2) study the resource use efficiency of cotton seed production for farmers in the study region. Salem and Kallakurichi district was purposively selected for the present study since it occupied the large position in area and production of Cotton seed and this district has black soil which is suitable for cotton production. The total cost of production Cost A1 Rs.57510.14 for GMS method and Rs. 57107.16 for Conventional method of contract farming. The R2 value of 0.88 indicates that about 88% of the variation in cotton profit and R2 value 0.93 indicated that about 93% of the variation in cotton yield by GMS method of contract farming was influenced by the explanatory variables and the R2 value of 0.52 indicates that about 52% of the variation in cotton profit and R2 value 0.71 indicated that about 71% of the variation in cotton yield by Conventional method of contract farming is influenced by the explanatory variables included in the model.

Keywords: Cost of Cultivation, Net return, Resources use efficiencies cotton





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INTRODUCTION

Cotton is a soft, fluffy staple fiber that grows in a boll, or protective case, around the seeds of the cotton plants of the genus *Gossypium* in the mallow family Malvaceae. The fiber is almost pure cellulose, and can contain minor percentages of waxes, fats, pectins, and water. Under natural conditions, the cotton bolls will increase the dispersal of the seeds. The plant is a shrub native to tropical and subtropical regions around the world, including the Americas, Africa, Egypt and India. The greatest diversity of wild cotton species is found in Mexico, followed by Australia and Africa. Cotton was independently domesticated in the Old and New Worlds. The fiber is most often spun into yarn or thread and used to make a soft, breathable, and durable textile. The use of cotton for fabric is known to date to prehistoric times; fragments of cotton fabric dated to the fifth millennium BC have been found in the Indus Valley civilization, as well as fabric remnants dated back to 4200 BC in Peru. Although cultivated since antiquity, it was the invention of the cotton gin that lowered the cost of production that led to its widespread use, and it is the most widely used natural fiber cloth in clothing today. Current estimates for world production are about 25 million tonnes or 110 million bales annually, accounting for 2.5% of the world's arable land. India is the world's largest producer of cotton. The United States has been the largest exporter for many years.

Contract Farming

Contract farming is defined as "a system for the production and supply of agricultural or horticultural products under forward contract between producers/suppliers and buyers. The essence of such an arrangement is the commitment of the cultivator to provide an agricultural commodity of a certain type at a time and a price and in the quantity required by a known and committed buyer, typically a large company" (Ghosh, 2007). According to the contract, the farmer is required to sow the contractor's crop on his land and to harvest and deliver to the contractor a certain amount of produce based upon anticipated yield and contract acreage. This could be at a pre agreed price. Sometimes contractor supplies inputs like seeds, plant protection chemicals, fertilizers in addition to technical advice required for cultivation of a crop while farmer manages the farm. Contract farming can be understood as a firm lending "inputs" such as seed, fertilizer, credit or extension to a farmer in exchange for exclusive purchasing rights over the specified crop. Thus, a useful starting point is the recognition that contract farming sits somewhere between fully vertically integrated investments (when a firm is involved in all the nodes of the value chain, from production, through processing to marketing) and spot markets (where price determination is a function of supply and demand). Contract Farming is one viable mechanism to overcome high risk and build up long viable partnership for better marketing. In this context contract farming will give a great solution and also it encourages Indian farmers to compete with very large, rich and highly indirectly subsidized western farmers. Hence, contract farming defined as legal agreement between the farmer (producer) and sponsor (buyer) at a predetermined price at a specific time. The main objectives includes to study the cost of production of GMS and Conventional method of contract farming and to study the resource use efficiency of cotton production on and Conventional method contract farming situation.

MATERIALS AND METHODS

This study is of an analytical nature and is based on primary dataset. The primary dataset was collected from 380 cotton seed cultivating farmers in the villages of Varagur, Narakkurichi, Thiyaganur village of Talaivasal block Salem district and Kallanatham, Karunguli, Maravanattam village of Chinnasalem block Kallakurichi district in the state of Tamil Nadu. These villages were purposely selected as contract farming sites for cotton seeds cultivation by the Contract Company. The Contract Company is JK Agri Genetics Limited., Ajeet Seeds, Kaveri Seeds and Shriram Bioseed Genetics. The sample was divided into two GMS (Genetic male sterilization) and Conventional crops. The sample comprises 195 GMS contract farmers and 185 conventional contract farmers. The sampling design of this study is based on complete enumeration sampling methodology. The farmers were sourced from the list of Contract company's field staff and extension workers from the Department of Agriculture, Tamil Nadu





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Cost Analysis

In order to assess the profitability and economic viability of cotton seed cultivation, various components of cost were estimated. The details of these cost analysis are given as

Cost A1: it consists of all actual expenses in cash and kind incurred in production the owner operator. It includes cost of hired human labour, cost of manures, cost of fertilizers, cost of pesticide, irrigation cost, interest on working capital, land revenue and depreciation of fixed capital.

Cost A2: Cost A1 plus rent paid for leased in land

Cost B1: Cost A1 plus interest on value of owned fixed capital assets

Cost B2: Cost B1 plus rental value of owned land and rent paid for leased in land

Cost C1: Cost B1 plus imputed value of family labour

Cost C2: Cost B2 plus imputed value of family labour

Cost C3: Cost C2 plus 10% of Cost C2

Resource-use efficiency

To analyses the resource-use efficiency and resource productivity of different inputs, the production function analysis was conducted. The Cobb-Douglas production function was selected to establish the input-output relations with output (yield) of the crop as the dependent variable and human labour, farm power, fertilizer, irrigation and plant protection measures were adopted as the independent variables. It was applied in the form of equation-

 $Y=a X1^{b1} X2^{b2} X3^{b3} X4^{b4} X5^{b5} X6^{b6} X7^{b7} X8^{b8} U$

Where,

Y = Crop Yield (Kg/ha)

A = Constant

 b_{1-8} = Regression coefficient

 X_1 = Human labour (Rs/ha)

 X_2 = Farm Power (Rs/ha)

 $X_3 = NPK (kg/ha)$

 X_4 = Irrigation (No.)

X₅ = Plant Protection (Rs/ha)

U = Random error term

RESULT AND DISCUSSION

In this section an attempt is made to present the various costs of cultivation under the well established cost framework in the literature on agricultural cost. The so established cost structure includes cost A1, cost A2, cost B1, cost B2, cost C1, cost C2 and cost C3. The costs are examined for both the groups of GMS method and Conventional method of contract farming, under the cost framework. Table ---- shows the data on different types of costs of production of cotton seed cultivation which is under GMS method and Conventional method of contract farming. From the table it could be observed that the total cost of production, cost C2 of cotton seed cultivation under GMS method is 116771.73 whereas the cost C2 of cotton seed cultivation under Conventional method is 111656.17. As such cost of cultivation under GMS method is high as compared to Conventional method of cultivation. In respect of cost of cultivation the GMS method of contract farmers are certainly placed in an advantageous position. This is due to the fact that the Conventional methods of contract farmers have to pay more for the cotton seed cultivation.

RETURN ON COTTON SEED CULTIVATION UNDER GMS METHOD AND CONVENTION METHOD OF CONTRACT FARMING.

Table ---- present details on various estimates of returns on GMS method and Conventional method contract farming. At the outset it may be noted from the table that the yield from cotton cultivation is of two kinds viz., cotton and cotton seed under both the method of contract farming. It must be mentioned here that the cotton seed from the Conventional method of contract farming commands much higher price as compared to the price of cotton seed





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obtain from the GMS method of contract farming. Because cotton seed under Conventional method of contract farming holds the natural content but cotton seed from GMS method of contract farming hold hybrid variety so does not hold much value. This is the reason why as the table ---- reveals the gross income is lower Rs. 199002 in respect of GMS method of contract faming as compared to Conventional method of contract farming Rs. 256241.71. Another reason is that the income from cotton is also low. As such the Farm business income, owned farm business. This is the reason why, as the table ----- reveals, the gross income is lower Rs. 199002 in respect of GMS method of contract farming as compared to Conventional method of contract farming Rs. 256241.71. Another reason is that the income from cotton is also low. As such the farm business income, owned farm business income, family labour income and farm investment income all are lower under GMS method of contract farming as compared to Conventional method of contract farming. The company enters into contract mainly to procure cotton seed cultivation. Otherwise this company as also other companies procure cotton cultivation at higher rate from farmers in the study village. The average price paid for cotton seed is Rs. 410 per kg in GMS method and Rs. 500 per kg in Conventional method. It seems that the contract farmers of cotton are largely at a disadvantageous position in terms of marketing and price. The contracting company under study seems to exploit the contract farmers. Because the opportunity cost of cotton cultivation under GMS method and Conventional method of contract farming is found to be higher in the study area. It could be seen from the table 6.18 that coefficient of multiple determinations R2 was 0.880 revealing that the production function model was a good fit. The R² value of 88.00 indicates that about 88 per cent of the variation in cotton cultivation by contract farming was influenced by the explanatory variables included in the model. In log linear production function, the coefficient is representing the production elasticity of the resource used. Positive relationships of input cost on profitability on GMS method of cotton cultivation and as a result are line with the previous studies (Rengaraju, R., G. Kokila and Azhagesan, R. 2023). It could be seen from the table 6.19 that coefficient of multiple determinations R² was 0.937 revealing that the production function model was a good fit.

The R² value of 93.00 indicates that about 93 per cent of the variation in cotton cultivation by contract farming was influenced by the explanatory variables included in the model. In log linear production function, the coefficient is representing the production elasticity of the resource used. Positive relationship of input cost on Yield on GMS method of cotton cultivation and as a results are line with the previous studies (Rengaraju, R., G. Kokila and Azhagesan, R. 2023). It could be seen from the table 6.21 that coefficient of multiple determinations R² was 0.529 revealing that the production function model was a good fit. The R2 value of 52.00 indicates that about 52 per cent of the variation in cotton cultivation by contract farming was influenced by the explanatory variables included in the model. In log linear production function, the coefficient is representing the production elasticity of the resource used. Positive relationships of input cost on profitability on Conventional method of cotton cultivation and as a result are line with the previous studies (Rengaraju, R., G. Kokila and Azhagesan, R. 2023). It could be seen from the table 6.22 that coefficient of multiple determinations R² was 0.710 revealing that the production function model was a good fit. The R² value of 71.00 indicates that about 71 per cent of the variation in cotton cultivation by contract farming was influenced by the explanatory variables included in the model. In log linear production function, the coefficient is representing the production elasticity of the resource used. Positive relationships of input cost on yield on Conventional method of cotton cultivation and as a result are line with the previous studies (Rengaraju, R., G. Kokila and Azhagesan, R. 2023).

CONCLUSION

The analysis has revealed that the input cost has increased over time. The cost of irrigation and intercultural has shown significant relation with total return. The negative return indicated that the cost of inputs have increased at increasing rate. The highest (8.89 percent) input cost growth rate was observed in case of plant protection. Whereas the lowest cost growth rate was found in case of seed. The major share (28.53 percent) in the total cost of production was that of land rent and minimum was that of seed (2.13 percent). In order to assist farmers to cover the loss, either cost of inputs should be decreased or the cotton support price be increased so that the cotton should continue





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growing seed cotton. If there exists an increasing trend in the input cost, the cotton growers will shift gradually to other competitive crop.

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Table 1: Cost of Production

S.No.	Particulars	GMS	Conventional
1	Value of hired human labour	27456.91	27727.54
2	Value of owned machinery labour	345.37	263.10
3	Value of hired machinery charges	4195	5246
4	Value of seedling	-	1
5	Value of pesticides	3919	3693
6	Value of manure	2878	2916
7	Value of fertilizer	14049	13218
8	Depreciation on implements and farm building	1182.05	951.22
9	Irrigation charges	2236	2042
10	Interest on working capital		1050.30
11	Cost A1		57107.16
12	Cost A2= Cost A1 + rent paid for leased in land		76891.85
13	Cost B1= cost A1 + interest on value of owned fixed capital assets	57908.67	57389.72
14	Cost B2= cost B1 + rental value of owned land and rent paid for leased in land	97908.67	97144.41
15	Cost C1= cost B1 + imputed value of family labour	79771.73	71901.48
16	Cost C2= cost B2 + imputed value of family labour	116771.73	111656.17
17	Cost C3= Cost C2 + 10per centof cost C2	128448.90	122821.78

Source: Field survey data

Table 2: Return on GMS and Conventional contract farmers

S.No.	Various Measures	GMS	Conventional
1	Average area under crop (in acres)	0.77	1.01
2	Jint (Seed) Average yield (per acre)	345.09	316.17





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	Lint (cotton)	230.00	210.89	
	Jint (Seed)	410	500	
3	Average price (per Kg)			
	Lint (cotton)	250	450	
4	Gross Income	199002	256241.71	
5	Farm business income		206430	
3	(gross income-cost A1) (Rs/acre)		200430	
6	Owned farm business		186645.31	
0	6 (gross income-cost A2) (Rs/acre)		100045.51	
7	Family labour income		166362.75	
7	(gross income-cost B2) (Rs/acre)		100302.73	
8	Farm investment income	82230.27	151850.99	
(gross income-cost C2) (Rs/acre)		02230.27	131630.33	

Table: 3 Coefficient of resource use efficiency on profitability

S.No.	Variables	Beta	Standard Error	t-value	Significance
1	Intercept	-1001.300	3399.750	-0.295	0.769*
2	Input cost	2.378	0.063	37.626	0.000***
	R ²	0.880			
	Adjusted R ²	0.879			
	F- Ratio	1.416			

Source: *** Ho is rejected at 1 per cent High Significance ** H0 is rejected at 5 per cent Significance * H0 is accepted at 5 per cent Not Significance

Table: 4 Coefficient of resource use efficiency on Yield

S.No.	Variables	Beta	Standard Error	t-value	Significance
1	Intercept	-2.068	9.836	-0.210	0.834*
2	Input cost	0.010	0.000	53.352	0.000***
	\mathbb{R}^2	0.937			
	Adjusted R ²	0.936			
	F- Ratio	2.846			

Source: *** Ho is rejected at 1 per cent High Significance ** H0 is rejected at 5 per cent Significance * H0 is accepted at 5 per cent Not Significance

Table: 5 Coefficient of resource use efficiency on profitability

S.No.	Variables	Beta	Standard Error	t-value	Significance
1	Intercept	65318.907	10457.231	6.246	0.000***
2	Input cost	2.107	0.147	14.330	0.000***
	\mathbb{R}^2	0.529			
	Adjusted R ²	0.526			
	F- Ratio	205.343			

Source: *** Ho is rejected at 1 per cent High Significance ** H0 is rejected at 5 per cent Significance * H0 is accepted at 5 per cent Not Significance





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Table: 6 Coefficient of resource use efficiency on Yield

S.No.	Variables	Beta	Standard Error	t-value	Significance
1	Intercept	135.769	21.783	6.233	0.000***
2	Input cost	0.006	0.000	21.142	0.000***
	R ²	0.710			
	Adjusted R ²	0.708			
	F- Ratio	446.980			

Source: *** Ho is rejected at 1 per cent High Significance ** H0 is rejected at 5 per cent Significance * H0 is accepted at 5 per cent Not Significance





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REVIEW ARTICLE

Non-Pharmacological Management Strategies for Insomnia in Older Adults: A Narrative Review

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ABSTRACT

The proportion of elderly persons experiencing mental illness is increasing. The symptoms of insomnia are prevalent health issues among the elderly population, and they are frequently linked to both physical and mental health conditions. Insomnia can have negative effects on one's quality of life, physical and mental health, and sleep patterns, among other things. We will use relevant search phrases to search the electronic databases PubMed, Medline, and Google Scholar between January 2015 and January 2023. An open-source reference management tool called Zotero was used for research on bibliographic data management. 55 articles that satisfied the inclusion criteria were first reviewed. After evaluation, 64,693 citations from January 2023 to the start of 2015 were added to PUBMED. Following the application of the inclusion and exclusion criteria, 64,638 publications were removed. The current study discovered that physiotherapy, cognitive behavioural therapy, and acupuncture were among the several nonpharmacological treatments for insomnia.

Keywords: older adults, insomnia, pathophysiology of insomnia, sign & symptoms, causes, management strategies





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INTRODUCTION

The population of today is aging quickly. The percentage of individuals over 60 will probably rise from 12 to 22 percent worldwide in the next 30 years. According to long-term cohort studies, the percentage of people with mental disease is rising, with 22% of older adults reporting having a mental disorder. Depression is the second most prevalent mental illness in this age range, after dementia.[1]. But only around one-third of older persons with depression who receive treatment experience remission; the other sixty percent of cases are assumed to stay untreated. Moreover, many elderly people who experience depression never get a diagnosis or treatment [2]. The American Academy of Sleep Medicine's (AASM) International Classification of Sleep Disorders, Third Edition defines insomnia disorder as the inability to fall or stay asleep, even after having plenty of opportunity to do so. It is characterized by persistent and recurrent issues [3,4]. Sleep quality is often disturbed by insomnia, which likewise has a detrimental effect on general well-being, physical and mental health, and performance during the day. It is evident that serious health and mental health issues are linked to insomnia and sleep deprivation. Numerous theories exist on the aetiology and pathophysiology of insomnia, the majority of which imply the involvement of both internal psychological processes and external stimuli [3]. The three components of the Spielman model of insomnia, also referred to as the "Three Factor" or "Three P" model, are predisposing, precipitating, and perpetuating [3]. Predisposing factors include social factors like bed partner incompatibility or societal constraints that result in an unpleasant sleep pattern, psychological qualities like the propensity to worry or ruminate, and attributes like sleep reactivity that raise an individual's chance of developing insomnia[5-6]. General therapeutic options for insomnia include treating underlying medical and psychological conditions, modifying medications and substances that interfere with sleep, and enhancing the sleep environment [7]. International guidelines state that the two most effective treatments for insomnia are medication and cognitive behavioral therapy [8,9]. Pharmaceutical companies have just recently been asked to submit long-term data for licensing purposes [10]. For insomnia, cognitive behavioral therapy (CBT) is recommended as the first line of treatment in addition to medication [11,12,13], and a standardized protocol has been developed specifically for this use. Offering CBT-I instead of medicine prescriptions for insomnia sufferers has the main benefit of having superior long-term benefits than sleep medication [14].

As non-pharmacological treatments for insomnia, exercise and physical activity have attracted attention [15, 16]. People who are physically active report better sleep quality, fewer sleep-related complaints, and less fatigue and drowsiness during the day[17]. Three meta-analyses of individuals with a diagnosis of depression demonstrated that exercise was an effective means of reducing depressive symptoms when compared to other types of controls, including usual care, no intervention, and placebo controls (Josefsson et al., 2014; Kvam et al., 2016; Schuch et al., 2016). [18] Numerous standardized randomized controlled trials (RCTs) have examined the utility of acupuncture for treating insomnia in recent years, leading to the publication of several good studies [19, 20, 21]. Several meta-analyses have shown evidence in favor of acupuncture's efficacy in treating insomnia [19, 22]. Only one-third of older persons who suffer from depression go into remission, and many more often than not, their illness remains untreated and unrecognized. Physiotherapy curriculum should be incorporated. Patients who come to physiotherapists with insomnia can receive physical therapy, behavior therapy, and a host of additional treatments. This literature review focuses on effective sleep treatment for insomnia.

MATERIAL & METHODS

Relevant keywords will be used to search PubMed, Medline, and Google Scholar, three electronic databases, between January 2015 and January 2023. Open-source reference management software Zotero was used to organize bibliographic data and related research resources..





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RESULT AND DISCUSSION

PHYSIOTHERAPY

- Caleb Ademola Gbiri1,3, Bosede Abidemi Tella1 In this study, 69 people who suffered from insomnia participated. For these people, structured physical therapy exercises have been shown to improve sleep patterns, improve quality of life, and increase functional performance. These exercises greatly lessen the intensity of weariness and symptoms of insomnia, improving day-to-day functioning and general wellbeing.
- 2. **Lilian Solis-Navarro**, **Olga Masot**, **Rodrigo Torres-Castro** A thorough search of Embase, PubMed/MEDLINE, Web of Science, and the Cochrane Register of Clinical Trials (CENTRAL) was carried out as of January 15, 2023. The results show that physical exercise regimens enhance older persons' sleep quality as measured by objective metrics.
- 3. **Carolina V R D'Aurea** et.al. Participants in a trial on chronic insomnia received three 4-month treatments: stretching (n = 10), resistance training (n = 10), and control (n = 8). Patients with chronic insomnia showed significant improvements in both objective and subjective sleep measurements following both moderate-intensity resistance training and stretching.
- 4. **Shehab M Abd El-Kader¹, Osama H Al-Jiffri²** Eighty people with chronic primary insomnia, ages 35 to 56, participated in this study. Random assignment was used to place participants in the supervised aerobic exercise intervention group (Group A, n = 40) or the control group (Group B, n = 40). Aerobic exercise training is a non-pharmacological way to improve immune system performance, psychological health, and quality of sleep for people with persistent primary insomnia.
- 5. **Faizul Hasan¹, Yu-Kang Tu², Chih-Ming Lin** The impact of different exercise regimens on older individuals' sleep quality was examined in randomized controlled trials that were included in the systematic review and network meta-analysis. The study, which used a frequentist-based random-effects approach, lends credence to the idea that exercise can enhance the quality of sleep for people in this particular cohort.

COGNITIVE BEHAVIORAL THERAPY

- 1. **Elisabeth Hertenstein** ¹, We focused on randomized controlled trials involving people with insomnia and any mental condition in our systematic review and meta-analysis. We looked through the databases PsycINFO (Ovid), CINHAL (Ebsco), and PubMed. It is crucial to give cognitive behavioral therapy for insomnia (CBT-I) top priority as an initial treatment option for people with mental problems and concomitant sleeplessness because of the numerous negative consequences of medication.
- 2. Faizul Hasan ^a, Yu-Kang Tu Researchers conducted a systematic review and network meta-analysis to examine the efficacy of digital cognitive behavioral therapy for insomnia between the start of the study and June 27, 2020, using four electronic databases. Using validated questionnaires or sleep diaries, primary outcomes were evaluated with an emphasis on self-reported metrics such as total sleep time, sleep onset latency, wake after sleep onset, sleep efficiency, and insomnia symptoms. The results of this network meta-analysis point to the effectiveness of digital cognitive behavioral therapy in lowering wakefulness after sleep onset and increasing sleep efficiency and duration.
- 3. **Tanja van der Zweerde** ^a, **Lampros Bisdounis** We compared cognitive behavioral therapy for insomnia (CBT-I) with non-active control groups in 30 randomized controlled trials (RCTs) to examine the long-term effects of CBT-I. Our results show that CBT-I is consistently successful, leading to notable clinical benefits that last for up to a year after therapy starts.
- 4. **Zainab Alimoradi¹, Elahe Jafari** The data about how cognitive behavioral treatment for insomnia (CBT-I) affects quality of life (QoL) outcomes across a range of groups, delivery methods, and methodological quirks was compiled in this systematic review and meta-analysis. Although the pooled estimate of the standardized mean difference (SMD) for QoL was 0.46, care should be used when interpreting this result because of





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variability and a lack of statistical power. For more thorough insights, future research should concentrate on examining moderating factors including distribution strategies and the particular QoL metrics used.

5. **Manu Thakral¹, Michael Von Korff** In this systematic literature review and meta-analysis, we sought randomized controlled trials of cognitive behavioral therapy for insomnia (CBT-I) involving adults (aged ≥18 years), focusing on measures of sleep-related beliefs. We conducted searches in Comprehensive, Medline, CINAHL, and PsychInfo databases from 1990 to 2018. The findings indicate that CBT-I offers varying degrees of improvement in maladaptive beliefs about sleep, ranging from subtle to substantial benefits.

ACUPUNCTURE THERAPY

- 1. **Wenya Pei,¹ Rui Peng**, To investigate the effect of acupuncture therapy on insomnia, we performed a bibliometric analysis utilizing papers from the Web of Science Core Collection (WoSCC) spanning two decades (1999-2018). We examined authorship, citations, nations, organizations, journals, and publication patterns using Citespace V. In recent clinical trials and systematic reviews, acupuncture especially electroacupuncture and acupressure—has received a lot of attention, particularly from Asian populations who have shown a greater willingness to adopt these treatments.
- 2. **Jinhuan Zhang¹, Yuhai He** · Using Medline, EMBASE, and the Cochrane Central Register of Controlled Trials, we performed a systematic review and meta-analysis of randomized controlled trials (RCTs) comparing acupuncture therapy to sham or placebo acupuncture for insomnia from the time of the trial's start until March 16, 2020. There is no discernible difference between electroacupuncture and minimum acupuncture, according to our findings. Nonetheless, the results of this investigation indicate that acupuncture is superior to a placebo in terms of reducing the symptoms of sleeplessness.
- 3. **Sheila N Garland, Sharon X Xie, Kate DuHamel**, Participants in this 8-week randomized clinical experiment received either CBT-I or acupuncture, with 80 cancer survivors in each group. There were notable and long-lasting gains from both therapies. On the other hand, CBT-I proved to be more effective and is advised as the first choice for treatment.
- 4. **Chenyong Liu,**¹, **Yanan Zhao**, Participants in this randomized controlled experiment, which included sixty patients with chronic insomnia, were split into two groups of thirty, each, with one group receiving acupuncture treatments and the other receiving sham treatments. According to the study, acupuncture can significantly improve patients' sleep efficiency, quality, and latency in addition to relieving their symptoms of despair and anxiety in those who have cognitive impairments.
- 5. Chengyong Liu¹, Hanqing Xi The validity of relevant research was evaluated after a comprehensive search using four Chinese databases (CNKI, VIP, Wanfang) and four English databases (PubMed, Embase, Web of Science, The Cochrane Library). The results point to caution when endorsing acupuncture as the only course of treatment for people with severe depression and sleeplessness.

Faults in the methodological framework of 15 studies investigating the efficacy of acupuncture, cognitive behavioral therapy, and physical therapy to treat insomnia were found through a qualitative study of the literature on clinical research. These studies lacked crucial elements such as demographic information, primary outcomes, intervention specifics, non-pharmacological approaches, and a defined research design. Individuals differed in terms of their age, health, and inclusion/exclusion status in the study. Our narrative review is mainly concerned with studies that look at how insomnia affects the health of older people; these studies are usually arranged as systematic reviews, meta-analyses, or randomized controlled trials.

CONCLUSION

The literature on clinical research design was subjected to a qualitative examination. We found that the 15 trials evaluating the effectiveness of physical therapy, cognitive behavioral therapy, and acupuncture in treating insomnia lacked crucial methodological components. These components included the study design, primary outcomes,





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interventions, non-pharmacology approaches, and demographics. The research demonstrates that the study participants' age groups, health statuses, and inclusion and exclusion criteria varied widely. We incorporate the evidence on the impact of insomnia on the health of older persons in our narrative review. Most of these studies were designed as meta-analyses, systematic reviews, or randomized control trials.

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RESEARCH ARTICLE

Analytical Method Development and Validation for the Simultaneous Estimation of Sildenafil Citrate and Dapoxetine Hydrochloride in Bulk and Pharmaceutical Dosage Forms by RP-HPLC

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ABSTRACT

Hypersil C18 BDS Column (100 mm x 4.6 mm; 5m) was utilized as stationary phase to provide a straightforward, quick, sensitive, specific, and accurate HPLC technique for the routine quantitative analysis of selected drug samples. The chromatographic peaks were well defined and resolved with no tailing using a mobile phase composition of 0.1% orthophosphoric acid: Acetonitrile in the ratio of 50:50 and pH adjusted to 5.00.1 with sodium hydroxide at a flow rate of 1 ml/min effluents, monitored at 287 nm. Retention times for Sildenafil citrate (3.143 minutes) and Dapoxetine hydrochloride (4.00 minutes) were measured. All suitability criteria, including theoretical plates and tailing factor, were determined to be within acceptable ranges and meet ICH standards when assessing the system's applicability.

Keywords: Sildenafil citrate, Dapoxetine hydrochloride Method Development and Validation.





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INTRODUCTION

Principles used in pharmaceutical analysis can be traced back to a wide range of scientific disciplines, including physics, microbiology, nuclear science, electronics, and so on. Before jumping into a quantitative study, a thorough qualitative examination is required. Both qualitative and quantitative analyses typically require some sort of isolation phase. Standard quantitative analysis only requires two measurements to calculate the outcome. The first is the amount of sample mass or volume, and the second is the amount of analytical substance measured from the sample, which often concludes the analysis. [1] Sildenafil is a medicine used to treat erectile dysfunction and pulmonary arterial hypertension. It is marketed under the trade name Viagra, among others. Its efficacy in addressing sexual dysfunction in females remains undetermined. You can either swallow it or get an injection straight into a vein. There is normally a twenty-minute onset and a two-hour duration. Headaches, heartburn, and flushing are some of the most often reported adverse effects. Those who suffer from cardiovascular disease should exercise caution. Prolonged erection (priapism) can cause damage to the penis, eye issues, and hearing loss; these are rare but serious side effects. People using nitrates like nitroglycerin (glycerin trinitrate) should not use sildenafil since it can cause a dangerous reduction in blood pressure. When combined with an alpha blocker, sildenafil should be avoided within four hours. In 1989, while searching for a remedy for cardiac chest pain, Pfizer stumbled onto the drug. More over 2 million prescriptions were written for it in the United States in 2020, making it the 183rd most often prescribed medication that year. It's a drug that's been approved for generic use. In the United Kingdom, you can get it without a prescription. Dapoxetine, often known as Priligy, is a medicine used to males aged 18 to 64 for the treatment of premature ejaculation (PE). Dapoxetine promotes ejaculatory latency because it blocks a serotonin transporter, which increases serotonin's activity in the postsynaptic cleft. Dapoxetine, like other antidepressants in the selective serotonin reuptake inhibitor (SSRI) class, was initially developed for this purpose. Dapoxetine, in contrast to other SSRIs, is rapidly metabolized and excreted. Because of its rapid onset of action, it is effective in the treatment of PE but not depression. In 2004, Johnson & Johnson submitted a New Drug Application to the Food and Drug Administration (FDA) for approval of dapoxetine for the treatment of PE, which had been developed by the Eli Lilly pharmaceutical business and licensed to J&J in 2003.

MATERIALS AND METHODS

Optimized chromatographic conditions for estimation of Sildenafil citrate and Dapoxetine hydrochloride

The chromatographic conditions optimized are shown in Table 1. Optimized chromatographic conditions were applied for the simultaneous estimation of Sildenafil citrate and Dapoxetine hydrochloride in bulk and pharmaceutical formulations. When blank solution containing only the mobile phase without the drug was injected, no peaks were obtained. The typical optimized chromatogram is presented in Fig 1.

Method Validation

To evaluate the system's applicability, linearity, LOD, LOQ, precision, accuracy, ruggedness, and robustness, the designed and refined RP-HPLC technique was validated in accordance with international conference on harmonization (ICH) recommendations Q2 (R1).

Suitability of the System

Standard solutions of 50 g/ml Sildenafil citrate and 30 g/ml Dapoxetine hydrochloride were injected six times to test the system's viability. The measured RSD values were within the typical tolerance band (2%). The tailing factor and theoretical plates for both medications were calculated.

Linearity

To evaluate linearity, a range of concentrations from 12.5 to 62.5 mg/ml of Sildenafil citrate and 7.5 to 37.5 mg/ml of Dapoxetine hydrochloride were prepared by drawing out aliquots of 2.5, 5, 7.5, 10, and 12.5 ml from a stock solution.





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Five injections of 20 l of each sample solution at each concentration level were used to construct a calibration curve, which was then plotted with concentration on the X-axis and peak area on the Y-axis.

Precision

By injecting six repetitions of the same concentrations of LDP and SFB, we were able to determine the repeatability/method precision by calculating the % assay and %RSD for each component. Testing for reproducibility, robustness, and intermediate precision was conducted in the same laboratory using separate analyzers and equipment.

Robustness

The robustness of an analytical method is measured by its capacity to survive everyday use while remaining unaffected by minor but intentional adjustments to its parameters. We test the method's durability by perturbing it in the methods described below. Three separate analyses were performed, each time with the optimal parameters of 2 nm wavelength and 0.2 ml/min flow rate. The system's usability was evaluated in every conceivable setting.

Accuracy

The conventional method of adding was used in the recovery studies. The suggested method was applied to samples with known concentrations of 80%, 100%, and 120% of the analytes; the percentage recoveries were determined, and chromatograms were recorded.

Specificity

To prove the method's specificity, it must be shown that the retention times of Sildenafil citrate and Dapoxetine hydrochloride are unaffected by the presence of interference from the mobile phase (Diluent) and degradants. To determine the HPLC system's specificity, we injected blank, sample, and control solutions of Sildenafil citrate and Dapoxetine hydrochloride into the system.

Analysis of Marketed Formulations

P-FORE contains 30 mg of Dapoxetine hydrochloride and 50 mg of Sildenafil citrate, and their respective concentrations were determined using the RP-HPLC technique. We blended Sildenafil citrate and Dapoxetine hydrochloride and weighed out enough for 20 tablets. Powdered Sildenafil citrate (50 mg) and Dapoxetine hydrochloride (30 mg) were added to a 100 ml volumetric flask. To ensure that the drug was completely dissolved, the contents of the flask were sonicated for 15 minutes before the volume was brought up to 100 ml with mobile phase. After that, the components of the mixture were separated using a 0.45 m membrane filter. To fill a 100 ml volumetric flask, 10 ml of the aforementioned solution was taken and diluted with mobile phase. Blank, sample, and standard solutions should all be injected at the outset in volumes of 20 L.

Limit of Detection (LOD) and Limit of Quantification (LOQ)

Both the LoD and LoQ for Sildenafil citrate and Dapoxetine hydrochloride were determined using the calibration curve method. Solutions of Sildenafil citrate and Dapoxetine hydrochloride in the linearity range were prepared and injected (n = 3).

RESULTS AND DISCUSSION

System Suitability

Table 1 shows that the theoretical plate count for SFC and DTH peaks is greater than 3000, the tailing factor is less than 2.0, and the relative standard deviation is less than 2.0%. It was also determined that the peaks of SFC and DTH may be resolved within acceptable ranges.





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Linearity

Concentration ranges were examined to determine linearity. Inference of a correlation coefficient greater than 0.999 can be drawn from the data. It was also proven that there was a good linear relationship between peak areas and concentration by providing the corresponding slope and y-intercept values.

Precision

From the results in table 3, it is evident that the % RSD for SFC and DTH to be within 2%. Hence the method is precise, reproducible and rugged for 48 hours' study.

Robustness

Table 4 shows that despite our best efforts, no changes were made that would have altered the system suitability characteristics of resolution, root-mean-square deviation, tailing factor, or theoretical plate count of SFC and DTH. The findings, along with the optimal circumstances for the system's suitability characteristics, were provided. As a result, the approach was validated as robust to variations in the operational environment.

Accuracy

From the results in table 5, the % recovery for SFC and DTH found to be in the range of 98 –102% and the % RSD for LDP and SFB is less than 2%. Hence the proposed method was accurate

Specificity

The chromatograms reveal that the peak of the analyte of interest was pure, and that the excipients in the formulation did not interfere with the analyte of interest, because there were no co-eluting peaks during the retention time of LDP and SFB.

LoD and LoQ

The following equations (ICH, Q2 (R1)) were used to determine the SFC and DTH LoD and LoQ values, which are presented in table 6. This set's LOQ = 10 / S and LOD = 3.3 / S

Where is the response standard deviation and S is the calibration curve's slope.

The proposed method was able to estimate Sildenafil citrate and Dapoxetine hydrochloride in the tablet formulation with accuracy of 98.80 ± 0.249 and 99.21 ± 0.483 respectively which were tabulated in table 7.

CONCLUSION

Sildenafil Citrate and Dapoxetine Hydrochloride may be quickly and easily quantified simultaneously from their formulation using the RP-HPLC method that was developed and verified. It was determined that all validation parameters were suitably within ICH limitations. The proposed approach was found to be simple, accurate, precise, rugged, and resilient and can be incorporated into the routine examination of the marketed formulation; it was also found to be specific for the pharmaceuticals of interest regardless of the excipients present. To determine the amount of Sildenafil Citrate and Dapoxetine Hydrochloride in pure and medicinal dose forms, this approach can be used for quality control.

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Table 1: Optimized chromatographic conditions for SFC and DTH

Method Parameters	Optimization conditions		
Column	Hypersil BDS C18, 100 x 4.6 mm, 5μm,		
Flow Rate	1.0 ml/min		
Wavelength	287 nm		
Mobile phase	Ortho Phosphoric acid buffer: Acetonitrile in the ratio of 50:50 (pH 5.0)		
Column température	30°C		
Injection volume	20 μL		
Run time	10 minutes		
Diluent	Mobile phase		
Elution	Isocratic		
Needle wash	Water: Acetonitrile 90:10 (v/v)		
Retention time	SFC -3.126 min, DTH - 4.024min		

Table 2: Results of System Suitability parameters of SFC and DTH

Parameters	SFC	DTH
Retention time	3.126	4.024
Tailing factor	1.04	1.05
Theoretical plates	4639	5766





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Table 3: System precision data for SFC and DTH

S.No	Name	SFC		DTH	
		RT(min)	Peak Area	RT(min)	Peak Area
1	Injection-1	3.14	458949	4.03	2434242
2	Injection-2	3.136	460379	4.027	2437312
3	Injection-3	3.138	458485	4.028	2428099
4	Injection-4	3.14	461642	4.029	2442797
5	Injection-5	3.143	459999	4.032	2435358
6	Injection-6	3.143	460790	4.033	2447437
Mean	3.140	460041	4.030	2437541	
Standard Deviation	0.0028	1170.8	0.002	6788.36	
% RSD	0.0878	0.254	0.06	0.28	

Table 4: Robustness data for SFC and DTH

	!	SFC	DTH	
Name	RT	Area	RT	Area
	(min)	(μV ² Sec)	(min)	(μV ² Sec)
Standard	3.143	460435	4.033	2446540
Change in wavelength (±2) nm				
1. Wavelength at 285nm	3.155	471488	4.054	2484692
2. Wavelength at 289nm	3.155	474081	4.050	2488905
Change in flow rate at ±0.2ml/min				
1.Flow rate at 0.8ml/min	3.152	471451	4.047	2476230
2.Flow rate at 1.2ml/min	2.952	474021	3.986	2508102

Table 5: Accuracy results for SFC DTH

S No	Accuracy 80%		Accuracy 100%		Accuracy 120%	
	SFC	DTH	SFC	DTH	SFC	DTH
	Area	Area	Area	Area	Area	Area
	(μV ² Sec)	(μV ² Sec)	(μV ² Sec)	(μV ² Sec)	(μV ² Sec)	(μV ² Sec)
Injection-1	351245	1840323	467508	2448787	585132	3065735
Injection-2	351023	1839897	467565	2442313	584980	3051264
Injection-3	350846	1814465	467787	2430123	584466	3050035
Average	351038	1831562	467620	2440408	584859	3055678
*Amount added (µg/ml)	37.50	22.55	50.10	30.20	62.50	37.55
*Amount Recovered (µg/ml)	37.27	22.51	49.90	29.96	62.48	37.65
%*Recovered	99.34	99.77	99.58	99.12	99.90	100.30
Over all mean of three levels % Recovery	99.66					

^{*}Each value is a mean of three readings

Table 6: Limit of Detection and Limit of Quantification for SFC and DTH

	~					
Parameter Sildenafil citrate		Dapoxetine Hydrochloride				
L.O.D	0.4126	0.2712				
L.O.Q	1.2505	0.8219				



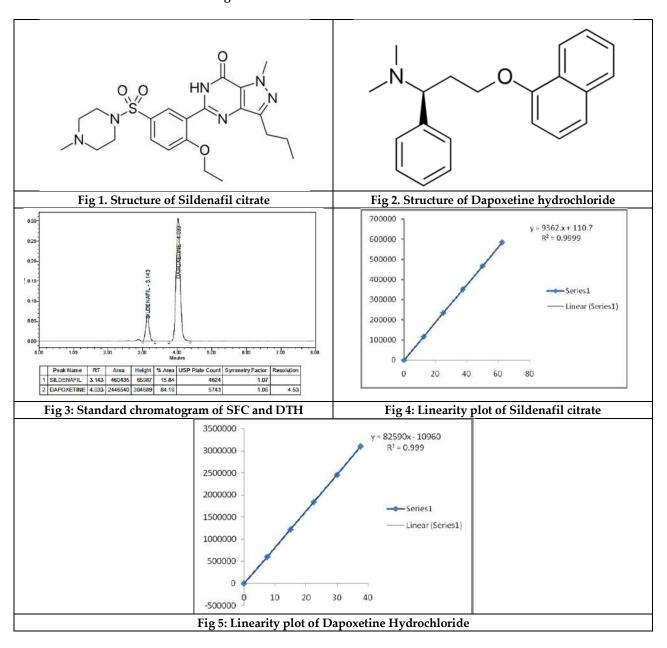


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Table 7: Analysis of marketed formulations (Assay) data for SFC and DTH

Drug	Quantity claim (mg/tablet)	*Quantity found (mg/tablet) ± SD	*% Assay found ± SD
Sildenafil citrate	50	49.40 ± 0.261	98.80 ± 0.249
Dapoxetine hydrochloride	30	29.76 ± 0.427	99.21 ± 0.483

^{*}Each value is a mean of three readings







RESEARCH ARTICLE

Microplastic and Histopathology Study of Different Fishes Species of River Mahanadi Due to Presence of Micro Plastic Pollutants in River Mahanadi Cuttack Odisha

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ABSTRACT

Changing of water's physical and chemical characteristics in any way that interfere with original condition will damage the aquatic ecosystem. Dumping solid waste such a plastic, metallic scrap, clothing and cosmetic waste garbage etc. cause presence micro plastic particles in aquatic channel and destroy the Marine organisms' .micro plastic causes' harmful impact in ecosystem in river water of Mahanadi Cuttack Odisha. Water samples collected from 20.453137lat-85.876258 long to lat.20.446549lat.85.873869 several locations and by the use of evaporation and size based separation method micro plastic particles can be separated from river water as well as by the KOH protocol by treating with 10% KOH solution and incubating by 40° c degree the micro plastic stress can be found in body of fish as well as by general histological procedure will be carried out in fish labeorohita and catlacatla to find out the impact of stress straining was done through the hematoxylin and your son in your son method and the several damage cells such as chloride cell epithelial cells lamellar disruption and hypertrophy of epithelium are found

Keywords: Micro plastic, Evaporation method, size based method, KOHprotocol, incubation, histopathology, hematoxylin, LabeorohitaCatlacatla





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INTRODUCTION

The Mahanadi River is a major source of water, carries a pollution load from industrial and agricultural areas of Orissa, India. Numbers of researchers have worked on the role of different urban and industrial effluents upon the water quality of Mahanadi River and estuarine systems. Due to industrialization and urban area release of Swiss water directly in water bodies lack of proper management of Waste, organic and inorganic and radiological waste mix in the water degrading the quality of usefulness of water .waste pollutants from the livestock operation volatile organic compounds heavy metals chemicals where others damage the water ecosystem. Micro plastic mix with water from plastic substance, food storage industry waste, cosmetic and clothing waste, the particles below 5mm pollute the river water and going through the body of aquatic organisms and affect their life. It causes cancerous effect by causing abnormal cell growth. Histological and biochemical changes occur due to the toxic effects of Malathion in C. punctatus (Pugazhvendan et al., 2009). A comparative study on the piscicidal activity of synthetic pesticides and plant origin pesticides to C. punctatus was conducted (Shahi & Singh, 2010). Due to the residual effects of pesticides, important organs like the kidney, liver and heart are damaged (Akter & Saha, 2013). Histopathological changes in the rainbow trout when exposed to sublethal concentrations of methiocarb or endosulfan have been studied (Altidok&Capkin, 2007). Among the considered endangered fish species, snake heads or murrells are the most familiar in Bangladesh and Channa punctatus is one of the most rare fish species of Bangladesh flood plains (Hossain et al., 2000). Histological and biochemical changes occur due to the toxic Effects of Malathion in C. punctatus (Pugazhvendan et al., 2009). Micro plastics as an emerging pollutant pose a threat to water quality and freshwater ecosystems as they can contain harmful chemicals, such as phthalates or polybrominated diphenyl ethers, and have the ability to adsorb, absorb, and release persistent organic pollutants (Crawford and Quinn, 2017). Micro plastics are anthropogenic pollutants that accumulate in marine and freshwater ecosystems globally,1 both in the form of engineered particles in consumer products (e.g., microbeads impersonal care products) and degradation products from larger Plasticproducts.2 Micro plastics are defined here as plasticparticles <5 mm.3(Jeff Wagner,*a Zhong-Min Wang, aSutapaGhosal, a Chelsea Rochman, bcMargyGasseld and Stephen Walla) Histopathological changes have been widely used as biomarkers in the evaluation of the health of fish exposed to contaminants, both in the laboratory (Wester and Canton 1991; Thompson et al. 2003).

OBJECTIVE AND METHODOLOGY

- To study the extent of degree of pollution especially solid waste pollutants (micro plastic) content of river Mahanadi Cuttack Odisha.
- To study micro plastic extraction by evaporation and size best separation approached by filtration method.
- Study micro plastic amounts from fish bodies by using KOH protocol by treating 10% KOH solution and incubating at 40c to identify plastic polymers.
- To carry out microtome procedure to find out the stress due to the pollution on fish.
- To observe the overall physiology damage of the fees in the stress condition by general histological procedure with will be carried out to find out the impact of stress straining done through hematoxylin and using method.

RESULTS

CONCLUSION AND DISCUSSION

The quality of water degraded by the mixing of micro plastics which flow with the water of river and contaminate the urban gems with several diseases and gorgeous light threatening effect and the hematological studies shows prominent damage in nucleus and neuron label and some particles of micror plastic found in the intestine and kidney of fishes.





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Table 1

River	Location	Area Type	Average number(±SD)of plastic particles (pcs/m3)	Microplastic in LaBeouf rohita	Microplastic in catlacatla
Mahanadi	1	Urban	56.0±5.7	96.1±5.0	84.8±3.0
	2	Industrial	354.5±12.0	65.8±13.9	65.8±21.0
	3	Rural	23.5±0.9	21.0±5.0	12.8±0.12
	4	Industrial	285.6±9.15	51.9±11.8	92.8±8.9
	5	Industrial	84.3±8.2	62.6±52.7	61.0±14.7
	6	Urban	21.5±12.0	54.9±12.0	25.8±12.5
	7	Urban	58.9±3.8	42.9±9.5	32.4±21.8
	8	Rural	12.0±1.9	11.0±0.9	10.5±2.9
	9	Industrial	89.5±32.0	52.0±21.9	48.9±21.6

Table 2: shows the amount of micro plastic present in water as well as fish body present in this area.

Location	Fish name	Chloride cell	Epithelial cell	Lamellar cell	Hypertrophy of epithelium
1	Labeorohita	1	0	0	2
	Catlacatla	0	1	0	0
2	Labeorohita	2	0	1	1
	Catlacatla	0	1	1	0
3	Labeorohita	0	2	1	0
	Catlacatla	1	0	0	1
4	Labeorohita	1	2	0	3
	Catlacatla	0	0	3	1
5	Labeorohita	1	1	0	0
	Catlacatla	0	1	0	2
6	Labeorohita	1	0	3	2
	Catlacatla	1	1	0	1





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7	Labeorohita	0	3	0	1
	Catlacatla	3	0	1	2
8	Labeorohita	1	0	1	2
	Catlacatla	2	1	0	1
9	Labeorohita	1	0	1	0
	Catlacatla	1	0	1	1





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RESEARCH ARTICLE

To Study Pulmonary Functions of Street Vegetable Vendors - An **Observational Study**

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ABSTRACT

Background: Street vegetable vendors face increased risk of lung disease due to environmental pollutants like NO2 and CO. Pulmonary function tests (PFT) assess lung health parameters. To study PFT results of street vegetable vendors in Ahmedabad, Gujarat. Ethical approval obtained; 100 vendors included. PFT measured FEV1, FEV1/FVC Ratio, and PEFR. 85 non-smokers and 15 smokers; both groups showed reduced pulmonary parameters, more significant in smokers. Weak negative correlation found between FEV1 and exposure duration. High prevalence of pulmonary dysfunction in smoker vendors compared to non-smokers. Weak correlation between FEV1 and exposure duration, though no clinical effect observed.

Keywords: PFT, street vendors, smokers, non-smokers.

INTRODUCTION

Air pollution has been generally recognized as a major health hazards, some of which are Geno toxins. The Numbers of vehicles driven has increased every year and has led to severe traffic congestion, causing high amounts of multiple pollutants to be emitted into outdoor.(1) So, It seems that exposure to road traffic pollution is associated with a higher risk for a sensitization to pollens and this could possibly be interpreted as an indication for development of pulmonary disease.(2) Occupational risk factors around the globe estimated were 37% of back pain, 16% hearing loss, 13% COPD, 11% asthma and 9% of lung cancer.(3) Since time, immemorial men have been the victim of occupational disease, among which lung diseases are most common. Subjects with workplace exposure to organic dust have high prevalence of respiratory disease. There is a growing consensus on the deleterious effect of organic dust on





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respiratory symptoms and functions of industrial workers which can lead to proliferative and fibrotic changes in lungs. (4) Street vendors are an integral part of economics around the world and it is a dominant occupation in urban areas of developing countries. They work daily settings their goods on sidewalk along streets and considered at most risk for developing lung disease because of prolonged working hours. They get exposed to pollutants that constitute nitrogen dioxide (NO2), O3, carbon monoxide (CO) and volatile chemicals (5). It is found that large number of vendors are having a habit of tobacco chewing and of smoking which will also increases the chances for developing lung cancer in a chronic stage. As there are large numbers of vendors engaged in this occupation in Ahmedabad city, it is mandatory to evaluate the health hazards and rate of increased disease risk among this population. As they work continuously on the streets they inhale polluted air for a chronic period which may irritate their airways, increased activity of mucus gland and may leads to coughing, wheeze and thus it may altered their pulmonary function. M.Nethaji et al. (2018) conducted the study to evaluate the extent of impairment in lung function in street vendors compared to general population (control group). In this study they had measures various pulmonary parameters by using portable spirometry and it shows changes in the FEV₁, FVC and PEFR, whereas other parameters were normal. It is due to effect of pollution by vehicular exhaust. Pulmonary function test help in the evaluation of the mechanical function of the lung by categorized as volume, flow or diffusion. PFT is used to differentiate obstructive, restrictive or mixed picture of the disease. It is used as a diagnostic procedure as well as for measuring the therapeutic effectiveness. So, basically it is used to measure lung volumes and capacities, presence and type of the respiratory disease. (6) Here PFT is done to check the prevalence of pulmonary obstructive/ restrictive lung disease in street vegetable vendors.

Ethical Approval

The study was performed after taking approval from the Institutional Research and ethics committee.

Study Type: An Observational Study. **Study Design:** A Cross Sectional Study

Study Setting: This study was conducted on various street vegetable vendors of Ahmedabad city.

Sample Design: Convenient Sampling

Study Duration: 6 Months **Sample Size:** N = 100

PROCEDURE

Before conducting the study ethical approval was taken from Institutional Research and Ethics Committee. Street vegetable vendors of Ahmedabad city was assessed and who met with selection criteria were included in the study, convenient sampling was used. Explanation of the procedure was given to the participants verbally and written consent was taken. After taking a detailed history and anthropometric data, subjects were informed about how to perform pulmonary function test. The subjects were encouraged to practice this procedure before doing pulmonary function test. Spirometry was performed by using an electronic clarity spirometer machine. All pulmonary function tests were carried out at a fixed time of the day to minimise the diurnal variation. The defined technique in executing various lung function tests for the present study were based on the operation manual of the instrument with special reference to the official statement of the American thoracic society of standardization of spirometry:

- First the spirometer was checked for calibration
- Next step was to measure height and weight of the individual
- Then subjects were asked about their any present or past illness and about medications
- The procedure was performed in standing position
- The subject was asked to stand straight and nose clip attached to their nose
- Then they were asked to keep mouthpiece in their mouth and close with lips
- The individual was asked to inhale completely
- Further individual were asked to exhale maximally until no more air could expelled out
- The test was repeated for three times after adequate rest of five minutes to avoid exertion. Best of three efforts was documented.





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The parameters included are; forced expiratory volume in one second (FEV1), Forced expiratory ratio (FEV1 / FVC), Peak expiratory flow rate (PEFR), Respiratory rate.

RESULT

The present study was conducted to observe pulmonary functions of street vegetable vendors by assessing forced vital capacity (FVC), forced expiratory volume in first second (FEV1), ratio of forced expiratory volume in first second and forced vital capacity (FEV1/FVC), peak expiratory flow rate (PEFR) Total 100 vendors of age group between 20-40 years with normal BMI were observed to check the effect of street vending on their pulmonary functions. Statistical data distribution and data analysis were performed by using statistical package of social sciences (SPSS) version 22.0 and Microsoft Office Excel 2016. The results were expressed in terms of percentage, mean, standard deviation and 'r' value.

DISCUSSION

Here total 100 vegetable vendors of age group between 20-40 years, with normal BMI, were observe to see the effect of street vending on their pulmonary functions which include FVC, FEV1, FEV1/FVC ratio and PEFR by using clarity spirometer machine. 50% has reduced FVC and 80% had reduced FEV1/FVC Ratio among street vegetable vendors. In overall population mean age was 31.8 ± 6.02 and body mass index was 23.3 ± 2.64 . Test normality was measured by descriptive analysis done in Microsoft Excel 2016. The overall effect of street vending on lung function was observed by using mean and standard deviation with the help of window 10 Out of 100 subjects 98% had altered spirometric function values; among which 2% were non-smokers. Result showed that there is a decrease in overall lung function parameters FVC, FEV1, FEV1/FVC ratio and PEFR. but reduction is more in smokers as compared to non-smokers. In non-smokers the PFT values are affected may be due to they are also get exposed to environmental pollutants. But reduction is more in smokers as compared to non-smokers and this affection in all PFT parameters are may be because of inhalation of cigarette which is the initiating factor to an inflammatory response in the airways and alveoli and can leads to respiratory disease. Cigarette smoking causes proteolytic injury to extracellular matrix and cell death. The airway wall become perforated and changing into abnormal airspaces. This chronic inflammation results in structural changes and narrowing of small airways due to increase mucus production. In a study conducted by Rubeena Bano et al (2009) reported decreased values of pulmonary function test parameters such as FEV1, PEFR and FEV1/FVC ratio in smokers compared to non-smokers and suggestive of obstructive lung disease commonly. The association between impaired PFT and smoking was also highly significant statistically. (33) Decreased FVC and FEV1 may be due to obstruction in the airways which increases with increase number of years of exposure. FEV1- It is the volume of air forcibly exhaled in the first second of expiration.

Environmental pollutants play an important role on respiratory system. Selling the vegetables on the streets, vendors inhaled solid particles or noxious gases since prolonged period then it can lead to changes in the volume and capacities of the lungs. It also depends on the route of exposure. There are some studies which suggest that these pollutants not only affect the respiratory system but also can lead to skin diseases, neurological and cardiological disorders too. A study done by Hironori Masuko et al (2011) suggest that there was no difference in annual decline of FEV1 between smokers compared to non-smokers. The group of healthy subjects with reduced value of FEV1 is a mixture which may be caused by more than one irritants such as smoking, allergens. (34) Another study done by S. Humerfelt et al (1993) suggested that smoking and occupational exposure to sulphur oxide gas, metal fumes and the number of specific agents were found to be important predictors for accelerated decline in FEV1 (35) FEV1/FVC ratio is decreased in smoker compared to non-smokers. This decreased ratio suggest that many street vegetable vendors are suffering from obstructive disease. Mostly reduction in FEV1 value is may be due to vehicular emission and airborne dust inhaled by street vegetable vendors. A study done by Hironori Masuko et al (2011) reported that a group of individuals who have normal or decreased FEV1/FVC Ratio are mainly smokers with higher cumulative tobacco consumption. (34) PEFR peak expiratory flow rate is achieved by maximum flow during maximal forced





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expiration. It provides an objective assessment of functional changes associated with environmental and occupational exposures which determines the stage acute or chronic disease. A study done by Virendra Singh et al (2003) reported that long-term exposure to air pollution can lead to increased PEFR variability even in a healthy subjects for which may be noxious gases are responsible (36) Another study done by M Boezen et al (1998) states that the particulate matter, black smoke and NO2 which indicates higher level of pollution have a significant effect on altered PEFR (37) In the present study more street vegetable vendors are likely to have a low PEFR, especially it is reduced in smokers may be because of inflammation which is common in smokers and also increase the thickness of the airway wall and have deleterious effect on respiratory tract though they are asymptomatic in acute stage. FEV1 and Duration of exposure – The present study includes both smokers and non-smokers and they do have significant changes in FEV1 with increased duration of exposure. The correlation was done by using pearson correlation test and the r value was found to be -110 indicating a weak negative correlation.

This long-term exposure to high level of air pollution may lead to variety of health complications. In future, there are some studies suggest that due to increment in the pollution and population everyday globally, long-term exposure by healthy adults also have adverse effect on their lung functions. A study done by Serya et al (2019) reported that when vendors are compared to shop assistants, street vendors exposed more to traffic fumes and vehicle emission directly for prolonged hours. So, there are chances of respiratory symptoms are higher and along with that it also shows decline in FEV1 and FVC parameters of pulmonary function test. (38) so, at the end my study shows declination in the FEV1, FEV1/FVC Ratio, PEFR pulmonary function test parameters suggestive of street vegetable vendors are showing the risk of developing obstructive lung disorders commonly, which increases with increased duration of exposure. Prevalence of risk for developing respiratory dysfunction in street vegetable vendors in this study is high among smokers because all the parameters FEV1, FVC, FEV1/FVC Ratio, PEFR affected statistically, as analysis is done by comparing the predicted value with observed value of the subjects. The greater declination or affection may be seen in case of chronic stage or with the subjects having any comorbidity. so, in the present study obstructive lung dysfunction is the commonest among those with altered PFT parameters in both smokers and non-smokers.

CONCLUSION

The result of the present study concludes that there is a decrease in the pulmonary functions of street vegetable vendors. In this study the street vegetable vendors have higher risk of obtaining obstructive type of pulmonary impairment and spirometry analysis shows statistical more affection in smoker compared to non-smokers. Due to their occupation, as the duration of exposure to environmental pollutants increases, FEV1 decreases.

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Table 1: Shows Mean Age and Mean BMI of Total No. Of SVVs

Street Vegetable Vendors	No. of subjects	Mean	Standard Deviation
AGE	100	31.86	± 6.02
BMI	100	23.35	± 2.64

Table 2: Shows Number of Affected Male and Female SVVs

SVV	Frequency	Percent
Male	73	73%
Female	27	27%
Total	100	100.0%

Table 3: Shows Number of Smoker and Non Smoker in SVVs

SVV	Frequency	Percentage
Smoker	15	15%
Non Smoker	85	85%
Total	100	100.0%

Table 4: Shows SVVs FVC Value Among Smokers and Non Smokers

SVV	Smoker	Non Smoker
FVC Predicted	3.16	3.18
FVC	2.28	2.56





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Table 5: SVVs FEV1 Value Among Smokers and Non Smokers

SVVs	Smoker	Non Smoker
FEV ₁ Predicted	2.90	2.87
FEV ₁	2.28	2.31

Table 6: SVVs FEV1/FVC Value Among Smokers and Non Smokers

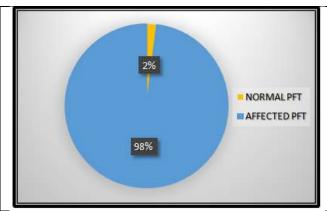
SVVs	Smoker	Non Smoker
FEV ₁ /FVC Predicted	91.98	94.55
FEV ₁ /FVC	81.49	83.30

Table 7: SVVs PEFR Values Among Smokers and Non Smokers

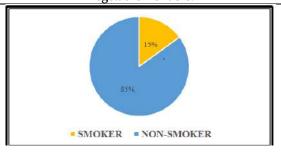
SVVs	Smoker	Non Smoker
PEFR Predicted	8.12	7.71
PEFR	6.39	6.42

Table 8: Correlation Between Duration of Exposure And FEV₁

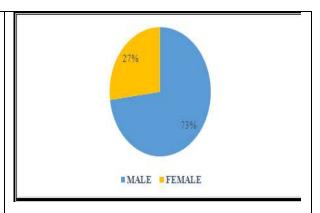
FFV ₁	DURATION OF EXPOSURE	'r' v	alue	N	P value
FE V1	Pearson correlation	1	10	100	< 0.01



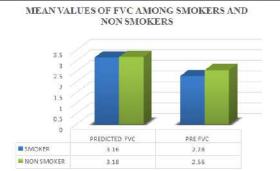
Graph 1: Prevalence of Affected PFT among Street Vegetable Vendors.



Graph 3: Shows Pie Chart Shows Number of SVVs 85% of Non Smokers and 15% Smokers



Graph 2: Shows Pie Chart Shows Number of SVVs 73% of Males and 27% Females.

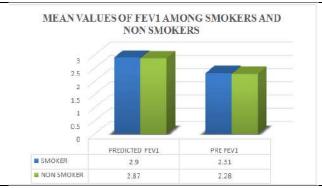


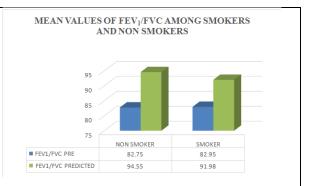
Graph 4: Shows Mean Values of FVC among Smokers and Non Smokers SVVs





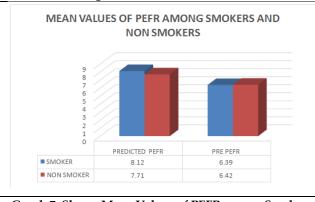
Kosha Gorand Hardini Prajapati

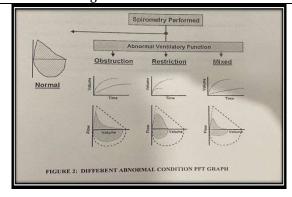




Graph 5: Shows Mean Values of Street Vending on FEV₁ among Smokers and Non Smokers SVVs

Graph 6: Shows Mean Values of Street Vending on FEV₁/FVC among Smokers and Non Smokers





Graph 7: Shows Mean Values of PEFR among Smokers and Non Smokers SVVs

Figure 1: Different Abnormal Condition PFT Graph

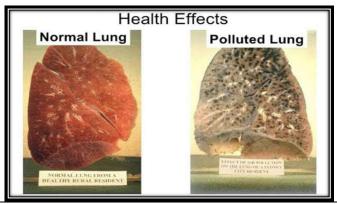


Figure 2: Effect of Occupation on Lungs





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RESEARCH ARTICLE

Weight Loss Strategies for Prevention and Treatment of Diabetes Mellitus in Females: A Narrative Review

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ABSTRACT

The area of medicine known as women's health is dedicated to the diagnosis and treatment of illnesses that have an impact on a woman's physical and mental health. Obesity, diabetes, and the related primary prevention and effective health promotion are becoming more common in India and around the world. Diabetes and other chronic diseases can be effectively treated with physical exercise and lifestyle changes. From January 2015 to January 2023, pertinent keywords will be used to search the electronic databases Pub Med, Medline, and Google Scholar. Bibliographic information and associated research materials were managed using Zotero, an open-source reference management program. A total of thirty papers were first screened and found to fulfil the inclusion criteria in databases including Pub Med, Medline, and Google Scholar. 56,214 citations were assessed in PUBMED between January 2015 and January 2023. 56,184 articles were eliminated following the application of inclusion/exclusion criteria, such as an abstract screen, a full text screen, and data extraction. According to the results of the current study, exercise is a useful "medication" for obesity and diabetes. Physical therapists should evaluate the patient's current level of physical activity as it may be necessary to modify their lifestyle in order to achieve the desired results.

Keywords: therapeutic approaches, causes of obesity, weight loss, diabetes mellitus, and prevalence of obesity in women.





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INTRODUCTION

Women's health is a specialty of medicine that focuses on the identification and management of conditions that affect a woman's physical and emotional well-being. Certain health issues affect both sexes equally, yet they affect women differently [1].[2] Depression is the most common mental health illness that affects women; in the US, more women than men are diagnosed with depression annually.[3] Sexually transmitted infections and illnesses affect women more severely.[4] Medical problems that go untreated might make women infertile.[5] Pregnancy-related diabetes is the most prevalent ailment in the world, and both the mother and the fetus should be spared harmful effects.[6] Due to the anatomy of the female urinary tract, women are more likely to have urinary tract issues such as urine incontinence.[7] One of the top NGOs for women's health is CHETNA.[8] It addresses this pressing need for the continuum of care by giving women, youth, and kids a voice in matters pertaining to their own nutrition, health, and well-being as well as those of their families and communities.[8] In order to increase the effect of its ongoing activities, CHETNA shares its vision with key partners through dialogues with multidisciplinary experts and practitioners.[8] The Journal offers a forum for physicians, surgeons, and other healthcare experts to share their research and educate the public on women's health issues, such as breast cancer, obstetrics, and gynecology.[9] Both in India and around the world, obesity is growing more prevalent. The prevalence of generalized obesity (GO), abdominal obesity (AO), and combined obesity (CO) varies from 11.8-31.3%, 16.9-36.1%, and 9.8-26.6%, respectively, across different regions of India, according to a study by the Indian Council of Medical Research - India Diabetes, ICMR-INDIAB-3.[10] The incidence of obesity is on the rise for a variety of reasons, such as increased calorie intake, altered food composition, inactivity, and alterations to the gut micro biota.[11] These days, obesity and its consequences-diabetes mellitus (DM), hyperuricemia (HU), hypertension, and cardiovascular disease (CVD)—are serious public health issues that place a heavy financial burden on society.[12] Individuals with diabetes are 2-4 times more likely to be obese than those without the disease.[13] Disrupted sleep habits caused by stress can also result in weight gain.[14] The poll found that women who practiced Buddhism and Jainism were less likely to be obese than women who followed the Sikh and Christian faiths.[15] Hyperglycemias, the disease's hallmark, is a complicated metabolic disorder with varying underlying causes among subtypes of diabetes mellitus.[16]

According to data from the World Health Organization (WHO), 74% of deaths globally in 2019 were not related to non-communicable diseases (NCDs). With 1.6 million fatalities globally in 2019, diabetes ranked as the ninth most common cause of death.[17] Uncontrolled diabetes increases the risk of vascular disease, and a significant amount of the burden associated with type 2 diabetes is attributed to micro, macro, and cerebrovascular issues.[18] In order to slow down the diabetes epidemic and lessen consequences related to diabetes in India, it is imperative that diabetes be prevented and managed, along with related effective health promotion and primary prevention, at both the individual and population levels.[19] In terms of the disease's pathogenesis, unusually high blood glucose levels are caused by a failure of the feedback loops between insulin action and insulin secretion. [20] Problems with β -cell activity limit the body's ability to maintain physiological glucose levels, which in turn reduces the generation of insulin.[20] T2DM, also known as adult-onset diabetes or non-insulin-dependent diabetes mellitus (NIDDM) in previous nomenclature, accounts for about 90-95% of all cases of diabetes.[21] Exercise has a substantial correlation with controlled glycaemic levels in T2DM patients.[22] A potent "medication" for diabetes and other chronic conditions is exercise.[23] Vital signs and heart rate at rest and during exercise, as well as important physical performance metrics (such as the 6- or 2-minute walk test and the 5-times sit-to-stand), should be shared with the physical therapist. An extensive analysis of how exercise affects diabetes [23] Physical therapists should evaluate the patient's current level of physical activity as part of lifestyle management and screen to find the safest and most suitable regimen for the patient. [23] The American Diabetes Association (ADA) recommends 150 minutes per week of aerobic exercise ranging from moderate to strenuous. There should be three days in a week that are dedicated to the activities, with no more than two days in a row being idle. Furthermore, it is advised to perform two to three sessions of resistance exercise and flexibility/balance training per week.[23] Physical therapists are vital members of the multidisciplinary health care team for at least three reasons: (1) they provide recommendations for safe and patient-satisfying physical activity participation.(2) advocating for routine physical activity in all patient interactions





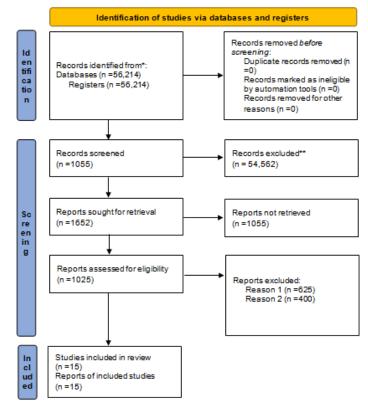
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as an essential component of the treatment of chronic diseases; and (3) assessing risk factors for diabetes and diabetes-related issues that modify the standard prescription of musculoskeletal exercise. [23] Food Adjustments: Food Adjustments and Medical Nutrition Therapy Consuming large amounts of sugar, fried food, and red meat is strongly associated with insulin resistance and the development of type 2 diabetes. On the other hand, eating veggies strong in antioxidants, fiber, and other nutrients is associated with a lower risk of developing type 2 diabetes. [24] The average energy consumption of patients with diabetes varies according on whether or not they are fat. For diabetic patients who are not obese, an average daily calorie intake of 1,500–2,500 is generally recommended; for those who are obese, an average daily calorie intake of 800–1,500 is recommended. Higher levels of stress are associated with poor treatment adherence and glycaemia control in persons with type 2 diabetes. [25] In general, women are less equipped and have less possibilities to cope with the effects of diabetes than males are. The current study set out to ascertain the role that weight reduction plays in preventing type 2 diabetes, as well as the connections between weight loss and cardiovascular risk, glycaemia control, and common co morbidities in T2DM patients. The purpose of this study is to compare the efficacious treatments for female diabetes mellitus with weight loss.

MATERIAL & METHODS

Relevant keywords will be used for the search through the electronic database PubMed, Medline and Google scholar from January 2015 till January 2023. An open-source reference management software Zotero was used to manage bibliographic data and related research materials. Keywords used are related to the are listed in Table 1. Keywords are women's health, Prevalence of obesity, Diabetes mellitus, Weight loss, Causes of obesity, Treatment strategies.

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RESULT

Physical therapy

- Swapnil P. Borse, et al. Type 2 Diabetes Management: Current Approaches, Ignored Factors, Difficulties, and Optionsdetermined that medical nutritional therapy, dietary modifications, physical therapy, and lifestyle adjustment.
- 2. Dagfinn Aune et.al. A comprehensive review and dose-response meta-analysis on physical activity and the risk of type 2 diabetes found that all forms of physical activity seem to be helpful. Up to 5-7 hours of leisure-time, vigorous or low-intensity physical activities each week have been shown to reduce risk.
- 3. Marcie Harris-Hayes, Mario Shootman Physical therapists must promote regular physical activity as a crucial part of the treatment of chronic diseases in all patient interactions, according to the conclusion of The Role of Physical Therapists in Fighting the Type 2 Diabetes Epidemic.
- 4. V S Conn¹, A R Hafdahl, D R Mehr, The results of the metabolic impact of treatments aimed at increasing physical activity in persons with type 2 diabetes indicate that self-management strategies that incorporate exercise recommendations enhance metabolic control.
- 5. Daniel Umpierre 1, Paula A B Ribeiro et. Al. A comprehensive review and meta-analysis examining the relationship between type 2 diabetes HbA1c levels and physical activity advice alone or formal exercise trainingconcluded that recommendations for physical activity are linked to decreased HbA(1c), but only in conjunction with dietary recommendations.

Lifestyle modifications

- 1. Prabha Shrestha¹ and Laxmi Ghimire According to a review, there is a way to prevent the rising trend in diabetes cases. This study focused on the impact of lifestyle modifications on diabetes and quality of life. A change in lifestyle that can prevent and lower the chance of acquiring diabetes and its consequences is necessary.
- 2. Chilot Kassa Mekonnen,et. al. Diabetes Mellitus Patients Receiving Care at the University of Gondar Comprehensive Specialized Hospital Northwest, Ethiopia: Knowledge, Attitude, and Practice Toward Lifestyle Modification and came to the conclusion that the study's findings demonstrated that patients' knowledge and attitudes regarding lifestyle modification were positive. Nevertheless, there was little progress made in changing one's lifestyle.
- 3. Thomas A Wadden¹, Meghan L Butryn, Christopher Wilson The use of lifestyle modification in the treatment of obesity has led researchers to the conclusion that it can cause clinically meaningful weight loss, which is linked to the reduction or elimination of cardiovascular risk factors.
- 4. Gagik R Galstyanet. al. Patients with type 2 diabetes mellitus and obesity who participate in the LIFE is LIGHT lifestyle modification program: Results from a 48-week, multicenter, non-randomized, parallel-group, open-label trial showed that using a comprehensive LMP led to improvements in BMI, waist-to-hip ratio, and HbA1c as well as a clinically significant weight reduction (≥5%) in patients with obesity and T2DM.
- 5. Klein Samuel et. al. Justification and tactics for managing weight through lifestyle changes in the prevention and treatment of type 2 diabetes. A joint statement from the American Diabetes Association, the North American Association for the Study of Obesity, and the American Society for Clinical Nutrition came to the conclusion that modest weight loss combined with increased activity can help patients with type 2 diabetes manage their glycaemic control and insulin sensitivity, as well as protect high-risk individuals (i.e., those with impaired glucose tolerance) from developing the disease.

DISCUSSION

This narrative literature review has examined the qualitative features of clinical research design. The ten trials that evaluated its utility in managing weight loss in obese women were all finished. Several crucial methodological





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elements, such as the status of procedures, primary outcomes, research design, demographics, and therapies, were found to be absent. The ten published studies that were found to be primarily concerned with gender-based health outcomes for women underwent a narrative evaluation. While randomized controlled trials were used to analyze a small number of interventions that addressed gender and health-related concerns, the bulk of this study was structured as systematic reviews or meta-analyses. The study's main treatment techniques were physical therapy and lifestyle modifications. Physical therapy and lifestyle adjustments were the two primary treatments that were the subject of the research that were located for this review. Policymakers should place a high priority on encouraging people to exercise regularly in order to maintain a healthy weight because obesity and sedentary behaviour increase risk.^[26]Exercise that is both frequent and intense can alter the way that insulin acts in the liver and muscles. Moderate-intensity aerobic exercise lasting at least 60 minutes is beneficial for adults who are obese and insulinresistant because it improves insulin function. The best course of action is definitely daily moderate- to high-intensity exercise if improving insulin action is the main objective.^[27] Self-management programs that incorporate exercise recommendations improve metabolic regulation, according to a study by V S Conn, A R Hafdah, et al., despite significant variance in the degree of the intervention impact. Interventions that emphasize exercise may be especially effective in improving metabolic control. Exercise is a common recommendation made by physical therapists for diabetic patients. Furthermore, physical therapists can assess for diabetic problems and risk factors and modify the recommended standard musculoskeletal exercises accordingly. Physical therapists have a duty to advocate for regular physical exercise as a crucial component of treating chronic conditions in all of their patient interactions. (Marcie Harris-Hayes, Mario Schootman, and others, 2019). Diet combined with exercise is the most effective preventative strategy to reduce the occurrence of diabetes (Li et al., 2008; Walker et al., 2010). In situations of poor glucose tolerance or fasting glucose, dietary and exercise adjustments can reduce the incidence of diabetes by 28-59% (Walker et al., 2010). Anti-diabetic drugs were found to be less effective than lifestyle changes (Diabetes Prevention Program Research Group, 2002).

CONCLUSION

Physical activity and exercise prescriptions should be given to all diabetic patients in order to manage their glycaemia control and general health. Exercise is associated with a lower HbA (1c), but only when combined with nutritional advice. Interventions that emphasize exercise may be especially effective in improving metabolic control. The findings of this study suggest that women should prioritize making lifestyle changes, such as cutting down on their daily idle time and alternating between extended periods of physical activity and sitting.

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REVIEW ARTICLE

The Enigma of Medication Related Osteonecrosis of the Jaw: A Review

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ABSTRACT

Medication related osteonecrosis of the jaws occurs as a side effect to certain drugs that include bisphosphonates, denosumab, and anti-angiogenic agents. These drugs used for treating cancer or bone diseases, may cause a gradual loss of bone in either or both of the jaws. Occurrence of osteonecrosis may depend upon the medication, its dosage, and the length of exposure. It is challenging to cure, has a high rate of morbidity, and a negative impact on quality of life. This review focuses on the existing research as well as future prospects related to pathophysiology, prevention and treatment of medication related osteonecrosis of the jaws.

Keywords: Osteonecrosis, Bisphosphonate-associated Osteonecrosis of the jaw, Denosumab, Antiangiogenic agents, Bisphosphonates

INTRODUCTION

Ischemia of bone leading to necrosis, is known as osteonecrosis and when involving jaws, it is termed as Osteonecrosis of jaws (ONJ). The term "bisphosphonate-related osteonecrosis of the jaws" or BRONJ was introduced by Marx in 2003 [1], in his study of 36 patients, he defined it as a maxillofacial area with exposed bone and evidence of delayed healing after therapy with I.V. bisphosphonates, similar cases were reported by other researchers as well





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during the same time frame [2]. The American Association of Bone Mineral Research and American Association of Oral and Maxillofacial Surgeons (AAOMS) described BRONJ as necrotic bone area exposed to the oral environment with more than eight weeks of permanence, in the presence of chronic treatment with oral or parenteral BPs, with no evidence of radiation therapy, in 2007 [3]. With the introduction of new anti-resorptive and anti-angiogenic drugs, BRONJ, in 2014, was suggested by AAOMS, to be renamed as medications-related osteonecrosis of the jaws or MRONJ. In AAOMS position paper, which was first put forth in 2009, updated in 2014 and then in 2022, MRONJ is now defined as the occurrence of the necrotic bone of the jaws that has been persistent for at least 8 weeks with a current or previous history of use of anti-resorptive or immunomodulatory or anti-angiogenic drugs [4]. It is mandatory to consider that the patient has not undergone former head and neck radiation. Some of the research has shown a direct correlation between MRONJ and primary disease, concurrent medications and the presence of regional risk factors which contribute to increased MRONJ incidence. Female and older patients have more preponderance for MRONJ. Mandible is more likely to be affected than maxilla, a study by Kang et al suggests that mandible is affected 2.7 times more than maxilla, which is contributed to more abundant vascular supply of maxilla as compared to that of mandible [5]. A meta-analysis conducted by Srivastava et al in 2021, suggests a prevalence of 19% for pamidronate-zoledronate therapy, 10% ibandronate-zoledronates therapy, 13% for bisphosphonatedenosumab therapy, 5% for bisphosphonate therapy alone and 4% for denosumab therapy alone [6]. According to a meta-analysis by Ishimaru et al in 2022, 0.06% patients with osteoporosis and 1.47% patients with cancer, develop MRONJ [7]. Surgeons face a challenge when treating a patient with MRONJ, operators must be knowledgeable about the proper course of treatment, the mechanism underlying the disease and preventive strategies. A collaborative effort is required by medical and dental fraternities, before starting therapy with causative drugs as well as during the treatment, the patient must be referred for dental screening so that prevention modalities can be carried out. Prevention strategies reduce the burden of MRONI by many folds but once the disease sets in, patient has to be referred to an oral and maxillofacial surgeon for further management.

DRUGS ASSOCIATED WITH MRONJ

Antiresorptive drugs, bisphosphonates and denosumab, are monoclonal antibodies against Receptor Activator of Nuclear Factor Kappa-B Ligand (RANKL) thus inhibit bone resorption, whereas Antiangiogenic drugs, e.g., Sunitinib, Imatinib, are humanized monoclonal antibodies directed against Vascular Endothelial Growth Factor Receptor (VEGFR) tyrosine kinases which are key regulators of vascular development.

- i. **Bisphosphonates:** BPs inhibit osteoclast mediated bone resorption and are used to treat skeletal pathologies such as osteoporosis, Paget's disease, multiple myelomas, osteogenesis imperfect, bone metastasis etc. These are stable and non-hydrolysable analogues of pyrophosphates that replicate the chemical structure of pyrophosphates by linking a carbon atom to two phosphonate groups. Etidronate and clodronate are examples of simple BPs (SBPs), whereas Nitrogen-BPs (N-BPs) include Pamidronate, Alendronate, Risedronate, Ibandronate, and Zoledronate. SBPs are metabolized intracellularly into non-hydrolysable Adenosine Triphosphate (ATP) analogues that are cytotoxic and cause osteoclasts to undergo apoptosis [8]. Contrarily, N-BPs have an impact on the cholesterol production pathway as they are potent farnesyl-diphosphate (FPP) synthase inhibitors, GuanosineTriphosphatase activity in cytoskeletal function and vesicular trafficking in osteoclasts is decreased by this inhibition [9]. More recently, it has been discovered that NBPs boost the expression of osteogenic genes in endothelium and mesenchymal stem cells, including bone morphogenic protein-2 (BMP-2), osteocalcin, and alkaline phosphatase [10].
- ii. **Biologic anti-resorptive drugs:** Denosumab is a humanized monoclonal IgG2 antibody that increases bone mineral density more effectively than alendronate [11]. In humans, osteoprotegerin (OPG) and RANKL, both of which are produced by osteoblasts, must coexist in a healthy balance for bone remodeling to occur. Preosteoclasts and osteoclasts both express the Receptor Activator of Nuclear Factor Kappa-B (RANK) receptor, which is activated by RANKL. Denosumab works by binding to RANKL by emulating the effect of OPG and thus, inhibiting its interaction with RANK, which reduces bone resorption by preventing osteoclast development, activity, and survival [12].





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- iii. Anti-angiogenic drugs: Vascular endothelial growth factor (VEGF) antagonists are administered in oncology cases and can be of two types, VEGF-binding monoclonal antibodies e.g., Bevacizumab, which block VEGF's biological activities; and small-molecule tyrosine kinase inhibitors (TKIs) e.g., Sunitinib, Sorafenib, Cabozantinib which interfere with the VEGF receptor and its downstream signaling pathways. However, full pathogenesis of MRONJ caused by anti-angiogenics is unknown but it is suggested that inhibition of angiogenesis has a negative impact on bone regeneration [13]. VEGF antagonists and TKIs also inhibit differentiation of osteoclasts.
- iv. **Immuno-modulatory drugs:** These are monoclonal antibodies which selectively bind to inflammatory response mediators and thus are used in immune system mediated diseases such as Rheumatoid arthritis, Crohn's disease, ankylosing spondylitis and certain oncology cases. These are anti-TNF alpha such as Infliximab, Rituximab, m-TOR inhibitors such as Everolimus, Sirolimus and other drugs include methotrexate and corticosteroids [14]. The pathogenesis behind this is not known yet but it has been suggested that anti-TNF alpha can cause inhibition of bone remodeling by apoptosis of osteoclasts whereas, m-TOR inhibitors have anti-angiogenic and immunosuppressive nature. Long term use of steroids causes avascular necrosis of bone especially when given concomitantly with bisphosphonates or denosumab. Methotrexate, the mainstay treatment of Rheumatoid arthritis, is a cytotoxic drug and it could inhibit osteoblastic proliferation.

PATHOPHYSIOLOGY

Even after years of research, the pathophysiology of MRONJ is still a mystery. Two theories that have emerged, the first one referred to as "inside-outside," is predicated on a fall in bone turnover and a reduction in osteoclastic activity, both of which are brought on by the previously mentioned drugs. There is a decrease in bone remodeling despite the localized inflammation and microscopic damage to the jaw brought on by mastication, which exposes bone to high concentrations of numerous pathogenic microorganisms on a continual basis. These circumstances result in the loss of bone tissue and subsequent bone exposure [15]. The second theory, known as "outside-inside," is predicated on a local immunological depression correlated with mucosal/dental lesions, which is most likely brought on by BPs or denosumab. Osteonecrosis would occur from this local infection and/or inflammation spreading to the bone. Dental conditions are a significant risk factor for MRONJ. Last but not the least, Sedghizadeb et al suggested that in MRONJ, exposed bone fragments are covered by a complex microbial biofilm, which may be the reason why antibiotic therapy is ineffective as conventional culture and sensitive techniques are not relevant for biofilms [16]. Elaborated pathophysiology includes,

Inhibition of osteoclastic activity and remodelling

Anti-resorptive medications affect osteoclast formation and function directly, as their main action is to decrease bone resorption and remodeling wherein increasing the bone density to prevent fractures in bone diseases such as osteoporosis. BPs are administered in bone malignancies as well. Denosumab is a more recent anti-resorptive drug. In reference to MRONJ both BPs and denosumab show equal preponderance [17]. Rodent studies support this hypothesis of MRONJ being caused by inhibition of osteoclastic activity by anti-resorptive drugs.

Bone turnover

Low bone turnover, a crucial factor in the effectiveness of anti-resorptive medications, has been hypothesized to have an impact on osteonecrosis. The risk of osteonecrosis is linked to higher anti-resorptive drug dosages [18]. However, the markedly decreased osteoclastic activity caused by the drugs would encourage osteopetrosis rather than osteonecrosis. No suppression of bone turnover was found in patients with osteonecrosis, according to numerous researchers. There isn't enough evidence to prove that micro fractures that form following slow bone turnover can speed up osteonecrosis [19].

Inflammation and infection

The earliest instances of osteonecrosis were observed after dental extractions, indicating that surgical trauma was most likely to blame. Numerous studies have connected inflammation and infection to the onset of osteonecrosis. It is not clear, nevertheless, whether necrosis appears before or after infection. Osteonecrosis has been linked to the





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concurrent use of antiresorptive medications with either infection or inflammation [20]. Local osteolysis, which is frequently found in osteonecrosis areas, may be caused by infection even while patients are taking high doses of antiresorptive medication. Microorganisms can increase the local production of cytokines, which can then increase osteoclastic activity, in addition to having direct effects on B cells and RANKL [21].

Inhibition of angiogenesis

The use of antiangiogenic drugs, such as VEGF inhibitors, tyrosine kinase receptor inhibitors, and immunomodulatory drugs, can be linked to MRONJ. Furthermore, the process of angiogenesis, which typically occurs during the healing of extraction sockets, is hindered by BPs. Both BPs and DMB have been proven to reduce the arterial area, venous area, and overall vascularity of periodontal tissues in both the initial and advanced stages of MRONJ. Treating MRONJ involves considering important factors like determining the boundaries of the disease, which can be challenging due to the presence of microvascular mucosal abnormalities near evident MRONJ lesions. It should be noted that the incidence of MRONJ in patients taking antiangiogenic drugs is much lower than in those taking anti-resorptive medications [22].

Immunosuppression

Osteonecrosis has been linked to immunosuppression as a risk factor. Chemotherapy drugs impair the immune system by changes microbiota and delays wound healing, increasing the risk of infection. Additional studies revealed that T regulatory cells, which control and prevent autoimmune illness, were activated in response to dexamethasone and anti-resorptive drugs [23]. Inhibiting the function of the immune system, anti-resorptive drugs, which promote the production of pro-inflammatory cytokines, acts as gamma delta T-cell receptor agonists, and subsequently reduce the number of T cells [24].

Cytotoxicity

Bisphosphonate toxicity can have an impact on both hard and soft tissues. Toxicity may result from prolonged use, high doses, or an accumulation of anti-resorptive drugs in bone tissue. Due to their local rather than systemic action, anti-resorptive drugs mostly cause damage to the jaws [25]. The toxic effects of the anti-resorptive drugs caused cell death, but the prevention of bone remodeling may also account for the necrotic regions. N-anti-resorptive drugs, which stop cell division, inhibit the farnesyldiphosphate synthase found in osteoclasts. Anti-resorptive drugs attach to bone, but soft tissue injury has also been observed [26]. A number of cell types, including cervical and oral epithelial cells, displayed decreased cell proliferation when exposed to anti-resorptive drugs in vitro.

RISK FACTORS FOR MRONJ

Age and sex can be risk factors for MRONJ, elder patients have more preponderance, and predominance of osteoporosis in middle aged, menopausal females has made them more prone to MRONJ. According to a study by Raje et al in 2018, the risk for MRONJ among patients taking Zoledronate to those taking Denosumab, is comparable which is 3% and 4% respectively [27]. Other drugs such as Tyrosine Kinase Inhibitors, immune suppressants like methotrexate and corticosteroids, radiopharmaceuticals, mTOR inhibitors etc. have also been suggested to be as risk factors but require further research. Among osteoporotic patients treated with BPs, the risk is 0.02-0.05% [28], when treated with RANKL inhibitors like denosumab, the risk is 0.04-0.3%, which is higher to that of BPs [29]. The risk among patients with non-malignant bone disorders taking Denosumab is comparable with that of patients with malignant diseases. In a study by Ng et al, the risk of MRONJ was 1.6-4% after 2 years and 3.8-18% after more than 2 years, when taking Zolendronate, with Denosumab it is 1.9% after 2 years and 6.9% after more than 2 years [30]. Other studies suggest no significant increase in risk even on being treated for more than nine years. Dentoalveolar procedures are the most common local risk factor for the MRONJ. Delayed healing following a dental extraction or other oral surgery is a common indication and symptom related with the diagnosis of MRONJ. Tooth extraction alone has a risk of 62%- 82% [31]. The risk is nearly 0%- 0.15%, if an osteoporotic patient is administered BPs following an extraction, for denosumab it is nearly 1%. For cancer patients exposed to BPs, a tooth extraction poses a risk of 1.6-14.8%. The risk after implant placement has been reported to be 0.5% [32]. In patients under risk, denture





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wearivng can be an additional risk factor. Periodontal disease is also a risk factor. Spontaneous MRONJ without any dental risk factor has also been reported.

CLINICAL PRESENTATION

To be diagnosed as MRONJ all the following three criteria are required to be met:

- i. Being prescribed an anti-resorptive or immune-modulatory or anti-angiogenic drugs in the past or present.
- ii. Exposed bone in the maxillofacial region or bone that might be accessed through an intra-oral or extra-oral fistula that has persisted for more than eight weeks.
- iii. Neither a history of jaw metastatic disease nor jaw radiation therapy [33].

STAGING BASED ON CLINICAL PRESENTATION

Different staging systems have been suggested in Table 1 and 2 [34].

RADIOGRAPHIC PRESENTATION

The radiographic characteristics of MRONJ are still somewhat nonspecific. In fact, because to the minimal degree of decalcification present and hence inadequate screening tools, In the early stages of the disease, conventional film radiography frequently fails to detect any abnormality. However, a localized or generalized osteosclerosis or thickening of the lamina dura on plain film imaging may be a sign of future locations of exposed, necrotic bone. Computed tomography (CT) is nonspecific, it is a useful tool for surgical treatment planning, it is much more likely to exhibit localized sclerosis, thicker lamina dura, early sequestrum development, and reactive periosteal bone. It is also much more susceptible to changes in bone mineralization [35]. Technetium-99m bone scanning is a highly sensitive imaging tool for detecting inflammation, which is usually present in people with established MRONI. MRONJ has received additional focus as a result of reports of increased tracer absorption in jaw regions that later developed necrosis [36]. Due to its modest specificity, nuclear imaging has little significance in individuals who already have the disease, but it seems to be useful as a prediction technique in patients with the preclinical disease (stage 0), necessitating further research. The early acute stage of osteomyelitis can be usually detected with MRI, which is also a highly sensitive imaging tool for detecting inflammation and osseous edema. However, because of its lack of specificity, its prognostic utility for spotting early disease is limited. A retrospective study by Belcher et al in 2014, investigated the sensitivity, specificity, and accuracy of Positron Emission Tomography (PET) in MRONJ revealed that it was impractical as a diagnostic tool [37].

HISTOLOGICAL FEATURES

The microscopic appearance of MRONJ is marked by empty osteocyte lacunae seen in necrotic bone trabeculae. The necrotic bone typically has bacterial colonies surrounding it and has uneven peripheral resorption as well as noticeable reversal lines. A consistent histologic finding has been characterised as actinomyces in contact with essential bone. The bony trabeculae's periphery and inter-trabecular gaps are home to osteoclasts with a large number of intra cytoplasmic vacuoles. Patients who underwent long-term oral bisphosphonate medication have been found to have large and highly nucleated osteoclasts. The empty Howship's lacunae are not rimmed with osteoblasts. There are no blood vessels in Haversian and Volkmann's canals. This microscopic discovery has been explained as showing that osteoclasts underwent apoptosis after ingesting anti-resorptive drugs. The inter-trabecular space incorporates inflammatory cells such as neutrophils, lymphocytes, and plasma cells [38]. The bone's marrow exhibits acellular collagen. The periosteum lacks cells and blood vessels.

DIFFERENTIAL DIAGNOSIS

Alveolar Osteitis, Sinusitis, Gingivitis/Periodontitis, Periapical Disorder, Temporomandibular Joint Diseases, Osteomyelitis, and Osteoporosis, possess comparable radiographic and histological characteristics with that of MRONJ, thus can all be differentiated from MRONJ by its clinical diagnostic criteria [39].





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PREVENTION

Prevention strategies of MRONJ include a thorough screening by a dental practitioner and dissemination of required dental treatment before starting and during with anti-resorptive/anti-angiogenic drugs.

- i. Before starting with anti-resorptive/anti-angiogenic drug therapy: The patient is to be educated about the potential threats of long-term anti-resorptive/anti-angiogenic drug therapy and that oral health optimization can take place simultaneously with therapy. If systemic condition permits non-restorable teeth or teeth with a poor prognosis must be extracted, restorable teeth should be restored and oral prophylaxis should be done [40].
- ii. During anti-resorptive/ anti-angiogenic drug therapy: The patient is to be educated about the significance of preventive dental treatment. Dentoalveolar surgeries should be avoided as far as possible. Drug holiday before dentoalveolar surgery is debatable [40].

TREATMENT

Multiple factors, including age, sex, disease, MRONJ stage, co-morbidities, and symptoms, influence the management of MRONJ. Two strategies are currently considered in clinical practice on a global scale: (1) conservative non-surgical management and (2) surgical management. The treatment planning is done according to the stage of the disease as mentioned in Table 3 [39]. We have suggested an algorithm for non-surgical and surgical management with respect to maxilla and mandible in FIG 1 and FIG 2, respectively [41].

DRUG HOLIDAY

For patients who are receiving anti-resorptive or anti-angiogenic drugs and are supposed to undergo a dentoalveolar surgery, a concept of drug holiday has been suggested in literature. In 2009, it was referred to as discontinuation of the anti-resorptive drugs for 3 months prior to and 3 months following a dentoalveolar surgery, if the systemic condition permits, in 2011 it was revised by ADA Council on Scientific Affairs as patient's receiving lower cumulative doses of anti-resorptive drugs that is less than two years, may continue with the regimen [42]. International ONJ task force suggests drug holiday in patients receiving anti-resorptive drugs for more than four years. However, there is no consensus on this available in literature. There is also a debate on risk benefit balance that is the benefit of drug holiday must outweigh the risk of loss of efficacy of anti-resorptive therapy and concomitant fractures following stoppage of drug regime, especially RANKL inhibitors in osteoporotic patients as research shows cases of rebound resorption. Time and duration of drug holiday is to be well planned. According to 2022 AAOMS position paper, dentoalveolar surgery can be completed within 3-4 months following the last dose of anti-resorptive drug that is when osteoclast inhibition is declining and then it can be continued 6-8 weeks post-surgery, this way the duration of drug holiday is kept short while providing good healing environment to the necrosed bone [43].

PROGNOSIS

Shin et al compared the pre-operative and post-operative staging given by AAOMS, in order to predict prognosis of the disease (Table 4) [38, 44].

ADJUVANT TREATMENT OPTIONS

- i. **Teriparatide:** It is a recombinant human parathyroid hormone that acts as an osteoanabolic agent by stimulating bone turnover and bone formation in osteoblasts and osteoclasts [45].
- ii. **Bone morphogenetic proteins (BMP-2):** It belongs to the family of transforming growth factors (TGF-beta). BMPs are thought to play a role in the growth and development of bone and cartilage [46]. BMP-2 has been employed in conjunction with surgery after the removal of necrotic bone, causing the production of new bone by osteoinduction. Om the other hand, some side effects such as inflammation, bone resorption, edema, seroma, and carcinogenic consequences have been noted with BMPs, therefore additional research is required to explore BMPs as a treatment for MRONJ [47].
- iii. Platelet concentrates: An additional, potentially effective treatment approach is the topical use of autologous platelet concentrate during bone excision. Growth factors such as platelet-derived growth factor (PDGF), transforming growth factor (TGF-alpha), vascular endothelial growth factor (VEGF), and epidermal growth factor (EGF) are abundant in platelet concentrates [48]. Platelet rich plasma and platelet rich fibrin, both have





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shown promising results. L-PRF however releases growth factors for a longer period. Application of platelet concentrate after surgery has shown better results than surgery alone. PDGF-BB is a recently introduced essential component that affects bone formation and angiogenesis. It is secreted by pre-osteoclasts, and it promotes the migration of mesenchymal stem cells and endothelial progenitor cells [49].

- iv. **Low-level laser therapy (LLLT):** It has been established that the treatment and prevention of MRONJ can be achieved with the use of an Nd: YAG laser or diode laser. The photochemical nature of LLLT promotes the vascularisation of a mucosal membrane, bone regeneration, and pain management.
- v. **Hyperbaric oxygen (HBO)** is a useful treatment that is mostly applied in challenging healing circumstances. This therapeutic effect is predicted to be influenced by an increase in oxygen concentration, immunological regulation, the generation of reactive oxygen species (ROS) and reactive nitrogen species (RNS), as well as other variables. HBO provides MRONJ patients with quick wound healing as well as reduced pain and swelling [50, 51].
- vi. Ozone therapy (OT): It has been demonstrated to be beneficial as an antibacterial, wound healing, vasculogenic and immunostimulant therapy [52, 53]. The natural antioxidant system is protected by MOT, while the xanthine/xanthine oxidase system is blocked for ROS generation. It also increases blood circulation. However, its usage lacks a protocol.
- vii. **Mesenchymal Stem Cells in MRONJ:** Multipoint stem cells are being employed more and more in regenerative medicine. These cells can be considered as grafting material in osteonecrosis foci because to their capacity to develop into osteocytes and also because of their immunomodulatory capabilities [54].

CONCLUSION

As it has been well established that prevention is better than cure, same goes for MRONJ as well. Once osteonecrosis sets in, it is difficult to manage but it can be prevented by following a set protocol of referring patients undergoing anti-resorptive or anti-angiogenic therapy for dental screening. Patients should be made aware of their risk of MRONJ based on their medication and oral health status. MRONJ once established, should be treated as per the stage of the disease. Future considerations include research on newer drugs with lesser adverse effects.

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Table 1: Different staging systems for MRONI by Marx and AAOMS (2009) [34]

Table 1: Differ	Table 1: Different staging systemsfor MRONJ by Marx and AAOMS (2009) [34]			
According to Marx (2007)				
Stages	Clinical features			
Stage 0	Subclinical damage, microscopically represented by hypocellularity, osteoclast apoptosis and decrease in endosteal osteoblasts			
Stage 1	A: painless exposed bone <1cm B: painless exposed bone >1 cm			
Stage 2	A: painful & infected exposed bone <2cm B: painful & infected single exposed bone >2cm			
Stage 3	A: multiple exposed bone areas without clinical finding of osteolysis, orocutaneous fistula orpathological fracture B: exposed bone >3cm or with clinical finding ofosteolysis, or orocutaneous fistula or pathological fracture			
	According to AAOMS (2009)			
At risk categories	No evidence of exposed bone/ necrosis in patients treated with bisphosphonates			
Stage 0	Non-specific clinical findings and symptoms (jaw pain orosteosclerosis) but no clinical evidence of exposed bone			
Stage 1	Exposed/necrotic bone in patients who are asymptomatic and who have no evidence of infection			
Stage 2	Exposed/necrotic bone associated with infections, evidenced by pain and erythema in the region of theexposed bone with or without purulent drainage			
Stage 3	Exposed/necrotic bone in patients with the pain, infection, and one or more of the following: pathological fracture, extraoral fistula, or osteolysis extending to the inferior border or sinus floor			





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Table 2: Different staging systems for MRONJ by SICMF-SIMPO and AAOMS (2014/2022) [34]

Table 2. Di	According to SICMF-SIPMO (2012) [34]				
	Focal MRONJ				
Stage 1	Clinical signs & symptoms: bone exposure, sudden dental mobility, non-healing post extraction socket, mucosal fistula, swelling, abscess formation, trismus, gross mandibular deformity and /or hypoesthesia / paraesthesia of the lips. Ct finding: increase bone density limited to the alveolar bone region (trabecular thickening or final osteosclerosis), with or without the following signs: markedly thickened and sclerotic lamina dura, persisting alveolar socket and/or cortical disruption 1a: asymptomatic 1b: symptomatic (pain and purulent discharge)				
	Diffuse MRONJ				
Stage 2	Clinical signs and symptoms: the same as stage 1 clinical findings: increased bone density extended to the basal bone (diffuse osteosclerosis) with or without the prominence of inferior alveolar nerve canal, periosteal reaction, and sinusitis, sequestrate formation and /or oroantral fistula. 1a: asymptomatic 1b: symptomatic (pain and purulent discharge)				
	Complicated MRONJ				
Stage 3	Same as stage 2 with one or more of the following clinical signs and symptoms: extraoral fistula, displaces mandibular stumps, nasal leakage of fluids CT findings: osteosclerosis of adjacent bone (zygoma, hard palate), pathological mandibular #and/ or osteolysis extending to the sinus floor.				
	According to AAOMS (2014 /2022)				
Patients at risk	Asymptomatic patients who have been treated with anti-resorptive therapy				
Stage 0	No clinical evidence of necrotic bone, but non-specific clinical findings, radiographic changes and symptoms				
Stage 1	Exposed and necrotic bone or fistula that probes to the bone in patients who are asymptomatic and have no evidence of infection/inflammation. These patients also may present with radiographic findings mentioned for stage 0 that are localized to the alveolar bone region.				
Stage 2	Exposed and necrotic bone, or fistula that probes to the bone, with evidence of infection/inflammation. These patients are symptomatic. These patients also may present with radiographic findings mentioned for stage 0 localized to the alveolar bone region.				
Stage 3	Exposed and necrotic bone or fistulae that probes to the bone, with evidence of infection, and one or more of the following-exposed necrotic bone extending beyond the region of alveolar bone (i.e., inferior border and ramus in the mandible, maxillary sinus and zygoma in the maxilla), pathologic fracture, extra-oral fistula, oro-antral/oro-nasal communication, osteolysis extending to the inferior border of the mandible or sinus floor.				

Table 3: Stages and treatment of MRONJ [39].

Stages	Treatment	
At risk	Patient education	
Stage 0	Symptomatic and conservative treatment, includes antibiotics and analgesics	
Stage 1	Antimicrobial mouthwash, regular follow up	
Stage 2	Antimicrobial rinse in combination with antibiotic therapy and analgesics, superficial debridement to ease soft tissue irritation and infection control	





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Stage 3	Antimicrobial rinse in combination with antibiotic therapy and analgesics, surgical
Stage 5	management

Table 4: Prognosis of MRONJ by comparing post-operative treatment outcomes with pre-operative stage [38, 44].

Outcome	Prognosis			
Absence of ONJ	Intact mucosa, absence of pain, and inflammation for at least three			
(post-operative stage 0)	months after surgery			
Reduced size of the lesion post- operatively	Partially exposed bone free of inflammation for at least three months			
No change in the size of lesion	Follow-up findings show no appreciable local improvement			
Increased size of the lesion post- operatively	Disease progression despite surgical intervention			





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REVIEW ARTICLE

Review of Additive Singular in Ternary Semiring

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ABSTRACT

The property additive left singular plays a main role here. A number of equivalent conditions were investigated. We examined when regular, left regular, lateral regular, right regular which are all coincides.

Keywords: Idempotent, Regular, Singular, Mono Ternary semiring.

INTRODUCTION

In 1932, D. H. Legmer [6] developed the initial triple algebraic structure. As commutative Ternary groups, he examined a particular type of Ternary algebraic structure denoted triplexes. Dutta and Kar [5] presented the idea of Ternary Semiring, which builds on Lister's concept of a Ternary ring [4] and regular Ternary rings were examined by Vasile in [7]. A non-empty set T with binary addition and Ternary multiplication is the basis of the algebraic structure known as Ternary Semiring, which, when multiplied by Left, Right, and Lateral distributive laws, generates a Ternary Semigroup and a commutative semigroup with respect to addition. The set Z^- is example of a Ternary Semiring also the juxtaposition (or) Ternary multiplication. The main objective of this article is to study T with addition is a left singular in a Ternary Semiring and their properties. In this research, we investigate additive left singular in a Ternary Semiring. By using additively left singular we investigated various properties of T.





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PRELIMINARIES

Definition 1. If T is an additive commutative semigroup that satisfies the following requirements, then a set that is not empty T with a binary addition and a multiplication of ternary structures, indicated by juxtaposition, together form a Ternary Semiring:

- 1. $stu \in T$,
- 2. [stu]vw = s[tuv]w = st[uvw],
- 3. [s+t]uv = suv + tuv,
- 4. s[t+u]v = stv + suv,
- 5. $st[u+v] = stu + stv \ \forall \ s,t,u,v,w \in T$

Definition 2. For any $s, t \in T$, (T, +) is a Ternary Semigroup considered left singular whenever s + t = s.

Definition 3. If $t + t = t(t^3 = t)$, then $t \in T$ is additively idempotent (multiplicatively idempotent).

Definition 4. If $t + t^3 = t$, then an element $t \in T$ is multiplicative subidempotent.

Definition 5. Ternary Semiring (T, .) satisfies the identity $st^2 = s$ ($t^2s = s$, tst = s), it is considered left (right, lateral) singular for all s, t in T. A (T, .) is regarded as singular if it's Lateral, Left, and Right singular.

Definition 6. If $s^2t = s + t$ (or $st^2 = s + t \ \forall \ s, t \in T$), then (T,+,.) referred as Mono-Ternary Semiring.

Definition 7. In T, an element 's' has become regular (additive regular) if there is an element $t \in T$ such that s = ststs(s = s + t + s), with some t being additive 1-inverse of s).

Definition 8. If $\exists x, y \in T \ni s = s^3xy$ ($s = xys^3$, $s = xs^3y$), then a Ternary semiRing (T,.) is considered left (right, lateral) regular. According to [3], a (T,.) is considered Regular whenever it's Lateral, Left, and Right regular.

Definition 9. A zero cube is defined as a ternary semiring *T*. Suppose that $s^3 = 0 \ \forall s \in T$.

MAIN RESULTS

Let T be a Ternary semiring and Using addition and multipication cancellation laws we have obtained some results.

Theorem 1. Assuming a Ternary semiring (T, +, .) and a left singular (T, +), the following are equivalent

- (i) (T,.) is multiplicative sub idempotent.
- (ii) (T, .) is idempotent.
- (iii) (T,.) is Mono Ternary Semiring
- (iv) (T,.) is singular

Proof: From (i)⇒(ii)

Since (T,.) is multiplicative sub idempotent we have $s+s^3=s$ for all $s \in T$ $s+t+s^3=s+t+s$ $s^3=s$

Therefore (T,.) is idempotent.





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```
From (ii)⇒(iii)
Since (T,.) is idempotent we get s^3 = s for all s \in T
s^2.s = ss^2(s+t) = s
s^3 + s^2 t = s
s + s^2 t = s
s+t+s^2t=s+t
t + s^2 t = t
t + s^2 t = t + s
s^2t = s
s^2t = s + t
Therefore (T,.) is Mono Ternary Semiring.
From (iii)⇒(iv)
Since (T, .) is Mono Ternary Semiring we have s^2t = s + t (or) st^2 = s + t for all s, t \in T
st^2 = s + t = s
left singular is obvious case. From equation (1)
s^2t = s
(s+t)st = s+t
s^2t + tst = s + t
s + tst = s + t
s + t + tst = s + t + s
(T,.) is lateral singular as a result.
Similar to that, we can show the right singular.
From (iv)\Rightarrow(i)
Since (T, .) is left singular we have st^2 = s for al s, t \in T
(s+t)t^2 = s+t
st^2 + t^3 = s + t
s + t^3 = s + t
s + t + t^3 = s + t
\mathsf{t} + \mathsf{t}^3 = \mathsf{t}
```

Therefore (T_n) is multiplicative sub idempotent. Similarly we can prove right and lateral singular.

Theorem 2. Let T be additive left singular, If T is a mono ternary semiring then (T,+) is idempotent.

Proof: since $s^2t = s + t \ \forall \ s, t \in T$

By Theorem (1) $s = s + s^3 = s + t$ and (T, +) is left singular, we have s + s = s

Hence, (T,+) is idempotent.

Remark 1. Converse need not be true in Theorem (2), which is illustrated in the following:

Example 1. Let $i, j, k \in T$, is a Ternary semiring

+	i	j	k		×	i	j	k
i	i	i	i		i	i	j	k
j	j	j	j		j	i	k	k
k	k	k	k		k	k	j	k

Here, T isn't mono ternary semiring if s = i, t = j, a where 's' is additive left singular, and idempotent.





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Theorem 3. The following are equivalent if (T, +, .) is ternary semiring and (T, +) is left singular.

- (i) 's' is additive idempotent $\forall s \in T$.
- (ii) 's' is additive regular $\forall s \in T$.

Proof: From (i)⇒(ii)

Since *s* is additive idempotent and left singular s + t + s = s

Therefores is additive regular, for some *t* belongs to additive 1- inverse of *s*.

From (ii)⇒(i)

Obvious.

Remark 2. Obtained the equivalent condition of additive regular and idempotent for additive left singular Ternary semiring, which is not true for multiplication.

Theorem 4. Assume that T be a Ternary semiring with additive, multiplicative left singular then (T, +) is regular.

Proof: By Definition (6) (T,.) is left singular. we take left singular

```
st^{2} = s
st^{2} = s + t
st^{2} = s + t + s
s = s + t + s
\therefore (T, +) \text{ has regular.}
```

Remark 3. If (T, +) is left singular and (T, .) is singular, then (T, +) is regular.

Remark 4. This shows that Theorem (4) is not always true as follows.

Example 2. Since s = i, t = j implies $st^2 \neq s$, we can conclude from Example (1) that (T,+) is a left singular and regular; hence, T isn't left singular w.r.t multiplication.

Theorem 5. Suppose T have a ternary semiring in which (T_r+) has a left singular. If T has idempotent w.r.t multiplication then (T_r) is regular.

Proof: Consider additive left singular and multiplicative idempotent s(s + t)s = s

```
s+sts=s ------(2) s+ssts=s s+s(s+t)sts=s s+sts+ststs=s Since (T,+) is left singular, equation (2) provides us with s+t+ststs=s+t+s. By ststs=s for some t \in s\{1\}
```

In general regular need not be equal left regular, lateral regular and right regular. Here we examined when the Lateral Regular, Left Regular, Right Regular and Regular are equivalent in the following theorem

Theorem 6. The following are equivalent if T is a ternary semiring with (T, +) is left singular:

(i) It is Regular if (T, .)

Therefore (T, .) is regular.

- (ii) It's Right Regular that (*T*,.)
- (iii) It's Left Regular that (*T*,.)
- (iv) It is Lateral Regular that (T,.)





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Proof: From (i)⇒(ii) For every $s \in T$ is regular, ststs = s for some t in TSince (T,+) is left singular we have $s + t^2sts = s$ -----(3) $s + t^2 s(t+s)s = s$ From Equation (3) we have $s + t^2 s^3 = s$ $s + t + tts^3 = s + t + s$ $tts^3 = s$ Therefore (T_r) is Right Regular. From (ii)⇒(iii) For every $s \in T$ is right regular, $tts^3 = s$ for some t in Ttt(s+t)ss = s $s + t^3 s s = s$ $s + t^3 s s = s + t$ $t^3ss = t$ Therefore (T, .) is Left Regular. From (iii)⇒(iv) For every $s \in T$ is left regular, $s^3tt = s$ for some $t \in T$ (s+t)sstt = s $s + ts^2 tt = s$ $s + ts^2(t+s)t = s$ From Equation (4) we have $s + ts^3t = s$ $s + t + ts^3t = s + t$ $ts^3t = s$ Therefore (T_n) is Lateral Regular. From $(iv) \Rightarrow (i)$ For every $s \in T$ is lateral regular, $st^3s = t$ for some t in T st(t+s)ts = tsttts + ststs = tt + ststs = tststs = tTherefore (T,.) is regular.

Remark 5. A regular element is not the same as left, lateral and right regular, as the following examples show: In general, $s \in T$ is regular.

Example 3. Let $i, j, k \in T$ is regular in a Ternary semiring

r			_		.,,			C
	+	i	j	k	×	i	j	k
	i	i	i	i	i	j	i	k
	j	j	j	j	j	j	i	j
	k	k	k	k	k	i	j	k

If we assume s = i, t = j, then (T,.) is not Left

Regular, Lateral Regular and Right Regular in T. However, (T,.) is regular.

Theorem 7. Assume that T with additive left singular. (T, +) is an idempotent if (T, -) is regular.





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Proof: Since *s* is left regular $s^3tt = s$ for any $t \in T$ according to theorem (6).

$$s^3t(t+s)=s$$

$$s + s^3 t s = s$$

 $s + s^3 t(s+t) = s$

From Equation (5) we have $s + s^3 tt = s$

s + s = s

Therefore (T,+) is an idempotent .

Remark 6. The following example shows that Theorem (7)'s converse is not always true:

Example 4. Assume that $i, j \in T$ is a Ternary Semiring.

+	i	j	×	i	j
i	i	i	i	j	i
j	i	i	j	j	i

(T, +) is Ternary left singular and s is additive idempotent, here we take s = i, t = j then 's' isn't regular in T.

Theorem 8. The following are equivalent consider T with (T, +) being left singular.

- (i) (*T*,.) is a Mono Ternary Semiring.
- (ii) $sst = s, \forall s, t \in T$.
- (iii) tss = s, $\forall s, t \in T$
- (iv) sts = s, $\forall s, t \in T$

Proof. From (i)⇔(ii)

Since T is Mono Ternary Semiring we have $s^2t = s + t \Rightarrow sst = s$

Converse is obvious.

From (i)⇔(iii)

Let sst = s

$$(s+t)$$
st = $s+t$

$$s^2t + tst = s + t$$

$$s + tst = s + t$$

-----(6)

s + ts(t + s) = s + t

From Equation (6) we get $s + t + ts^2 = s + t$

$$s+t+ts^2=s+t+s$$

$$ts^2 = s$$

conversly, we take tss = s

$$ts(s+t)=s$$

$$ts^2 + tst = s$$

$$s + tst = s$$







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```
s + (t + s)st = s

Equation (7) provides us the following: s + s^2t = s

s + t + s^2t = s + t + s

s^2t = s + t

From (i)\Leftrightarrow(iv)

Since Theorem (1) we have s + s^3 = s

s + s(s + t)s = s

s + sts = s

s + t + sts = s + t + s

sts = s

conversly, we take sts = s

s + st^2 = s

s + t + st^2 = s + t + s

st^2 = s + t
```

The following results needs the additive identity so we tkae zero is the additive identity in T.

Theorem 9. Suppose T have ternary semiring, where (T, +) left singular. T has become zero cube w.r.t multiplication with additive identity θ if T is Mono ternary semiring.

Proof. Let us take $s^2t = s + t$

Theorem (1) provides us the following: $s^2t = s^3$ $s^2t = s^3 + s^2t$ $s^3 = 0$

Therefore (T₁.) is zero cube.

Theorem 10. Let (T, +, .) represent a ternary semiring. with left singular in (T, +). If (T, .) has zero cube Ternary Semiring with additive identity 0 then baa = aab = aba = 0

Proof. Since (T,.) is zero cube Ternary Semiring $s^3 = 0$ for all $s \in T$

Taking $s^3 = 0$

(s+t)ss = 0

 $s^3 + tss = 0$

0 + tss = 0

tss = 0

Similarly we can prove sst = sts = 0

Theorem 11. The following holds true consider T with additive left singular, and (T, .) is regular for every $s, t \in T$ and $n \ge 1$.

- (i) $s^{4n+1} = s$.
- (ii) $s^{4n+1} + s = s$
- (iii) $t + s^{4n+1} = t$.
- (iv) $s^{4n+1} + t = s$
- $(v) \quad s + ts^{4n} = s$

Proof: (i) Since $s \in T$ is regular we have ststs = s for some $t \in s\{1\}$ s(t+s)sts = s

$$ststs + s^{3}ts = s$$
$$s + s^{3}ts = s + t$$

(8)





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$$s + s^3 t s = s + t + s$$
$$s + s^3 t s = s + s$$

$$s^3 t s = s$$

-----(9)

$$s^3 ts = ststs$$

$$sssts = ststs$$

$$s^3 = sts$$

-----(10)

Put Equation (10) in (9) we have

$$s^5 = s$$

From Equation (11) we have $s. s^4 = s$

$$s^9 = s$$

In general we have the following $s^{4n+1} = s \ \forall \ s \in T$ and $n \ge 1$.

(ii)From Equation (9) it has s(s+t)sts = s

$$s^3 ts + ststs = s$$

$$s + s^3 t s = s$$

$$s + s^5 = s$$

In general we have the following $s + s^{4n+1} = s \ \forall \ s \in T \text{ and } n \ge 1$.

(iii) From (ii) we get
$$s + t + s^{4n+1} = s + t$$

$$t + s^{4n+1} = t$$

(vi) From Equation (11) we have $(s + t)s^4 = s$

$$s^5 + ts^4 = s$$

$$s + ts^4 = s$$

$$s + ts^4 = s + t$$

$$ts^4 = t$$

Put Equation (14) in (12) we get $s^5 + t = s$

$$ss^4 + t = s$$

$$s^9 + t = s$$

In general we have the following $s^{4n+1} + t = s \forall s, t \in T$ and $n \ge 1$.

(v) From Equation (13) we have $s + ts^5 s^3 = s$

$$s + ts^8 = s$$

In general we have the following $s + ts^{4n} = s$ for all $s, t \in T$ and $n \ge 1$.

In the Theorem (11) if we substitute s, t value in various ways we can obtain some more results particularly using additive left singular in (v) implies $t + ts^{4n} = t$.





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CONCLUSION

In this paper we worked on additive left singular, in same manner we can obtain results for additive right singular also. Here we obtain the result regular, right regular, left regular, lateral regular are coincides only by the property additive left singular the reader one who may try to work on the same result for various conditions.

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RESEARCH ARTICLE

Formation and Engineering of Vanadium Pentoxide Nanoparticles by SDS Surfactant and their Structural, Optical, Morphological, and **Antimicrobial Behaviours**

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ABSTRACT

The structural, optical, and morphological properties of vanadium pentoxides (V2O5) nanoparticles have been investigated. Hydrothermally, vanadium pentoxide nanoparticles were synthesized utilizing ammonium meta-vanadate as a precursor and sodium dodecyl sulphate (SDS) as a surfactant. The product was annealed for two hours at 400°C to 600°C. XRD, UV-Vis, PL, FESEM with EDX, Raman, TGA, DTA, and antibacterial studies were employed to characterize the materials. The average crystalline size was 45nm, as confirmed by XRD. The band gap energy is 3.6eV at 400°C and 3eV at 600°C, according to UV-Vis absorption. Photoluminescence (PL) spectroscopy was used to explore photo-induced electrotransfer process in the title sample. The surface morphology has been studied using FESEM and EDX technique has been employed to identify the elemental conformation of vanadium and oxygen. Raman spectroscopy was used evaluated the crystallographic phase and degree of crystalline nature of the V2O5 NPs. TGA and DTA have lower masses, indicating an endothermic process. V₂O₅ antibacterial activity with SDS surfactant was effective response against gram-positive bacteria.

Keywords: V₂O₅, Nanoparticles, SDS, Antibacterial study, Surfactant.





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INTRODUCTION

One of the most active fields of research nowadays is the creation of one-dimensional nanostructures, such as nanowires, nanorods, and hollow tubes[1], [2]. One of the transition metals, vanadium, is prized in many industrial areas. In various fields, including solar cells[3], sensors[4], batteries and catalysts[5]-[8] its oxide form has demonstrated promising properties. Depending on their oxidation state/valence, the crystal structure and chemical properties of vanadium oxide vary[9]. The principal causes of vanadium's changing oxidation state are total vanadium concentration, pH, or extra incubation or pretreatment variables [10]. Vanadium's oxidation states range from +2 to +5. There are several V-O geometric arrangements of vanadium oxide, including VO, V2O3, VO2 and V₂O₅[11]. The stable orthorhombic structure of V₂O₅ has relatively higher electrical and optical properties than any other oxidation state of vanadium oxide[12]. Numerous application of vanadium pentoxide V₂O₅ have been thoroughly investigated. Because it is an intercalation compound, vanadium pentoxide has generated a lot of interest as an electrode for chemical pseudo capacitor applications. The two most extensively utilized energy storage technologies are now super capacitors (SCs) and lithium-ion batteries (LIBs), nevertheless, both have drawbacks linked to the charge storage process[13]. LIBs' ability to reload is critical in this regard because to their large volumetric energy and weight, high energy density, extended lifespan, and low self-discharge properties[14]-[16]. For a variety of portable gadgets, including digital electronics, laptop computers, and mobile phones, they are also thought to be the most effective form of energy storage[17]-[19]. Industrial water is frequently contaminated with organic-inorganic pollutants that are dangerous to human health. Hexavalent chromium ions are among the most significant and harmful contaminants detected in wastewater despite their high stability and solubility. Additionally, without proper treatment, synthetic organic chemicals used in our daily lives, such as colors and antibiotics, are released into water systems, causing pollution[20]-[23]. Vanadium oxides, with their peculiar structure, constitute a class of inorganic 3d transition metal oxide compounds that are particularly appealing due to their various electrical, optoelectronic, electrochromic and magnetic characteristics[24]. They can therefore be used in essential technical applications. The beneficial properties of V2O5 can be used to create electrochromic devices, information displays, and color memory devices[25], [26]. Due to their magnetic properties, oxides have many applications and are the subject of much research. Specifically, a family of oxides with magnetic properties related to structural defects resulting from the introduction of impurities into the crystal lattice or from the heat treatment used after the synthesis technique, which changes the concentrations of the impurities. Oxygen vacancies in the tested samples.

Some characteristics of V_2O_5 nanoparticles include chemical stability, electrochemical activity and absence of toxicity. It also has a special collection of smaller strip gaps. V_2O_5 is nevertheless frequently used in a variety of applications, such as antifungal and antibacterial agents in paints, wastewater treatment, textiles, and other products[27], [28]. The most sophisticated commercially accessible ultrasonic-assisted approach for producing metal oxide nanoparticles has been shown. Ultrasound is the most basic method for synthesizing V_2O_5 nanoparticles with an orthorhombic structure. Numerous pure V_2O_5 or nanocomposites have been described in research for photo-catalysis (against MB, Rhodamine B, and Methyl Orange) and antibacterial uses. In order to produce V_2O_5 nanoparticles in this study utilizing the hydrothermal method, ammonium meta-vanadate was utilized as a precursor and sodium dodecyl sulphate (SDS) was used as a surfactant solution. The product was incubated for two hours at two distinct temperatures (400°C and 600°C). To verify the effectiveness of the planned nanoparticle production, various approaches were used to characterize the vanadium nanoparticles. To establish an appropriate calcination temperature, the prepared samples were tested for structure, morphology, optical properties and antibacterial activity.

EXPERIMENTAL METHODS

MATERIALS

Ammonium meta-vanadate (NH₄VO₃), Sodium dodecyl sulphate (SDS surfactant), Nitric acid and De-ionized water were used during the experiment. Ethanol was used as received for the preparation of pure V_2O_5 nanoparticles.





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Preparation of vanadium pentoxide (V2O5) nanoparticles

50 cc of distilled water was used to dissolve 3.52g of NH₄VO₃ drank. After about 30min of stirring, the solution was set aside. 50 ml of distilled water was used to dissolve approximately 0.01g of SDS surfactant. Add the prepared NH₄VO₃ solution dropwise to the SDS solution. 50ml ethanol was added after the two solutions were combined. Then, to maintain a pH of 2-3, add approximately 5ml of nitric acid drop by drop. The solution was then vigorously stirred for about 60min. Before the solution was heated in an autoclave for 12 hours at 180°C, it was thoroughly agitated. The resulting residue was then washed five times with distilled water and once more with ethanol. The pure precipitate is subjected to the calcination process.

Characterization of nanoparticles

The dried powder endured X-ray diffraction (XRD) analysis utilizing a Cu K α radiation source with a wavelength of 1.5405 Å. The XRD was performed on an X-Pert Pro instrument operating at 60 kV and 40 mA, covering a 2 θ range of 20°–80° with a step size of 0.02° and a scanning rate of 5°/min. To investigated the band assignments, Fourier-transform Raman (FT-Raman) spectrometry was employed on a Bruker instrument within the wave number range of 0–1800 cm⁻¹, utilizing the Attenuated Total Reflectance (ATR) method. The optical properties of the samples were investigated through UV–Vis spectroscopy, conducted on a PerkinElmer Lambda-35 UV–Vis spectrophotometer, spanning wavelengths from 200 to 800 nm. Room-temperature photoluminescence (PL) spectra were obtained at a right angle using a photon counting spectrofluorometer PC1 from ISS (USA), with an excitation wavelength of 330 nm. The STA-8000 was utilized to gauge the temperature fluctuations and weight losses of the synthesized nanoparticles, providing detailed insights into their thermal behavior. For the analysis of nanoparticle morphology, a scanning electron microscope (SEM) model Ultra55 from Zeiss (Germany) was employed. Elemental compositions were determined using energy dispersive spectroscopy (EDS) with an X-max detector from Oxford Instruments (England).

Antibacterial analysis

Staphylococcus aureus (ATCC 6538), Bacillus subtilis (ATCC 6633), Escherichia coli (ATCC 8739), and Klebsiella Pneumonia (ATCC-10031) were acquired from the American Type Culture Collection (ATCC) in the USA. The antibacterial efficacy of the synthesized V_2O_5 NPs against both gram-positive (*S. aureus* and *Bacillus*) and gram-negative bacteria (E. coli and Klebsiella) was assessed using the well diffusion method. Muller–Hinton agar was poured into sterilized Petri plates and allowed to solidify, after which fresh bacterial cultures were evenly spread over the plates using the spread-plate method. Wells, each with a 5 mm diameter, were created in the agar medium using a sterile cork borer. The wells were loaded with a V_2O_5 nanoparticle solution at a concentration of 50 μ g/mL, and the plates were then incubated for 24 hours at 36 °C. Following incubation, the formation and measurement of the zone of inhibition around each well were observed. The presence of an inhibition zone indicates the antibacterial activity of V_2O_5 nanoparticles.

RESULT AND DISCUSSION

X-ray diffraction analysis

 V_2O_5 samples were prepared with surfactant at two different temperatures, 400°C and 600°C, as indicated in Fig. 1. XRD histograms of these samples revealed major diffraction peaks at 12.3°, 15.49°, 20.34°, 21.82°, 25.67°, 31.13°, and 32.11°, corresponding to (001), (200), (001), (101), (110), (400), (011), (310), (211), (002), (411), (600), (302), (012), (020), (601), (021), (412) and (710) diffraction planes. The lattice constant value was very similar to that in previous literature (JCPDS n° 89-0612)[29]. The diffraction peak at 2θ =12.3° with the (001) plane vanished at the annealing temperature of 600°C, as shown in Fig. 1. As the annealing temperature went from 400°C to 600°C, the intensity of the diffraction peak increased as well. According to Fig.1, the peak (001) at 2θ =20.34 indicated the alpha phase (orthorhombic structure). The Debye-Scherrer formula was computed using full width at half maximum (FWHM) measurements to determine the average size of the ordered V_2O_5 nanoparticles.

 $D = 0.9\lambda/\beta \cos\theta - - - (1)$





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Where D is the crystal size, and is the full width at half maximum (FWHM) of the highest intensity diffraction peak in terms of brightness, diffraction angle, and X radiation wavelength. Annealed V_2O_5 nanoparticles were discovered to be 45nm in size.

UV-Visible Spectroscopic studies

Fig.2 illustrates the UV-Vis spectrum of V_2O_5 nanoparticles, as well as their spectra at temperatures of 400° C and 600° C for comparison Fig.2(a and b). We investigated the behavior of V_2O_5 nanoparticles in deionized water using UV-Vis absorption spectroscopy. The spectrum shows two primary absorption bands at approximately 343nm and 492nm, respectively. These high absorption peaks result from the hole transition between V and O. The band gap of V_2O_5 nanoparticles is reflected in the absorption band above 450 nm. Notably, the spectrum's band/peak between 300nm and 700nm is shifted towards the lower end of the wavelength, indicating a clear blue shift. Due to the quantum size effect in V_2O_5 nanoparticles, this blue shift is explained[30]–[36]. Additionally, a shoulder peak at 630nm was observed due to surface oxygen vacancies during nanoparticle growth using surfactants[37]–[41].

Field Emission Scanning Electron Microscope

With the help of field emission scanning electron microscopy, the manufactured samples were analyzed. FE-SEM imaging confirmed the near-perfect shell of vanadium pentoxide nanoparticles and revealed a highly porous structure on the sample surface with increasing annealing temperature. SEM photos of the V_2O_5 sample in Fig.4 are shown at various magnifications. Fig.3 (a, b, and c) displays the morphology of vanadium pentoxide nanoparticles synthesized as nano-flakes at 400°C. The images depict a nano-cotton-like morphology with gaps between the fragments. This flaking morphology is known to result in better electrochemical performance[42]. Fig.3 (d, e and f) showcases images of V_2O_5 nanoparticles as nano-flowers from nano-sheets at 600°C. The FE-SEM images display well-dispersed flower-shaped nano-sheets, assembled from radially arranged nano-sheets with a diameter of about 1μ m[43]. The SEM images reveal that the V_2O_5 nanoparticles are randomly distributed and have good crystalline morphology of the agglomerated nanoparticles, with the smallest diameter of formed V_2O_5 nanoparticles being about 200nm.

Energy dispersive X-ray analysis

Figure 4 depicts a qualitative and quantitative elemental analysis of a prepared sample using an EDX spectrum. According to the analysis report, the element was found in the samples at different temperatures (400° C and 600° C). EDX spectra provide evidence of V and O in the sintered samples.

Photoluminescence Spectroscopy

Studies on luminescence offer details on the types of surface flaws and oxygen vacancies that affect optical characteristics. Shorter wavelength PL emission is produced by shallow defect levels in the valence band, while longer wavelength PL emission peaks signify energy transfer at deep defect levels close to the conduction band. The PL spectrum of a pure V₂O₅ sample annealed at 400 and 600 degrees Celsius and measured at room temperature for excitation wavelengths of 380 and 385 nanometers is shown in Fig. 5. The emission spectra of the nanoparticles were recorded after excitation with the obtained UV-visible spectra. Induced image electro transfer was studied by luminescence (PL) spectroscopy. The recorded PL spectrum for the prepared V₂O₅ nanoparticles was recorded at 380nm, as shown in Fig.5 shows the near-band edge emission of the spectrum recorded at 385nm. The increase in PL intensity is considered to be maximum at 600°C. The band gap's intermediate energy levels are not visible in the PL spectrum. The high crystallinity and defect condition that boost UV emission in the PL spectrum are responsible for this[44].

Raman Spectroscopy

Fig. 6 displays the Raman peaks of V_2O_5 nanoparticles, which were detected between 100 cm-1 and 1000 cm-1. The produced V_2O_5 nanoparticles have peaks that are symmetrical with the orthorhombic V_2O_5 phase's Raman modes. The V-O-V series oscillations are linked to the prominent peak at 143 cm⁻¹, and the presence of this peak shows that the V_2O_5 phase has an orthorhombic. The low frequency Raman scattering peaks at 143 cm⁻¹ are strongly releated





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with the layered structure. The bending oscillation V=0 corresponds to the peak at 284 cm-1. The oxygen-terminal stretching mode (V+5O), which is connected to the crystallization quality and stoichiometry of the thin layers [45]–[47], is shown by the peak at 995cm-1. The intensities of the V_3O phonon band and V-O-V modes, which were ascribed to the Raman peaks at 523 cm-1 and 696 cm-1, respectively, were found to be quite weak. The results demonstrate that it significantly improves its structural and optical properties. Raman spectra show that the low frequency area has more peaks with higher intensities. Raman spectra at these two temperatures were compared, and the intensity at 600°C was significantly higher than at 400°C. At high temperatures (400°C to 600°C), the thermal expansion of V_2O_5 nanoparticles produces very strong optical interference effects and considerably increases the raman intensity.

Thermal gravimetric studies

The temperature difference between the test sample and the reference sample is assessed using differential thermal analysis (DTA), and the mass change that takes place during heating is measured using TG analysis research. This makes it possible to spot changes in the sample relative to the inert reference, whether they are exothermic or endothermic. The V_2O_5 .nH2O sample's TGA and DTA records from ambient temperature to 700°C are shown in Fig. 7. When the sample is heated from 70°C to 280°C, as shown in Figure 8's first step, the sample's mass decreases as a result of the release of adsorbed water molecules between the layers, which are bound every week[48], [49]. The identical sample is heated from 280°C to 410°C in the second stage. The mass of the sample decreases due to the removal of all water molecules bound to V_2O_5 in the sample. These findings, which pertain to the transformation of SDS into liquid (the melting point of SDS is 206°C), are in line with data from the literature[50]. The sample is heated from 410°C to 500°C in the third stage. A significant reduction in volume might be used to describe this period. The remaining tightly bound water is released in the fourth heating stage by the vanadium nanoparticles at 500°C to 700°C, which also causes the sample of V_2O_5 to crystallize in its dehydrated orthorhombic form[51], [52].

In the fourth stage, mass is lost. The sample is still in the orthorhombic phase and is liquid. At 690° C, the DTA curve exhibits a steep decline. This indicates a very endothermic process, maybe brought on by the beginning of V₂O₅ crystallization. The V₂O₅.nH₂O samples' TGA and DTA records from room temperature to 700°C are displayed in Fig. 8. The first stage in Fig. 8 shows that the mass of the sample decreases when the sample is heated from 90°C to 200°C because the adsorbed water molecules between the layers, which are bound together on a weekly basis, are eliminated. The identical sample is heated from 200°C to 400°C in the second phase. The mass of the sample decreases due to the removal of all water molecules bound to V₂O₅ in the sample. The sample is heated from 400°C to 500°C in the third stage. A significant reduction in volume might be used to describe this period. Vanadium nanoparticles were utilized in the fourth heating stage, where they crystallized the V₂O₅ sample in the dehydrated orthorhombic form and caused the loss of any residual tightly bound water. In the fourth stage, mass is lost. The sample is still in the orthogonal phase and is liquid. At 690°C, the DTA curve exhibits a steep decline. This indicates a very endothermic process, maybe brought on by the beginning of V₂O₅ crystallization. Fusion of the samples and sample to orthorhombic phase. The endothermic values are the same in Figs. 7 and 8.

Antibacterial studies of V2O5 with SDS surfactant

According to the antibacterial activity results, SDS surfactant and V_2O_5 work together to act as an antibacterial agent for both gram-positive and gram-negative bacteria. The synthetic sample's antibacterial activity as determined by the disc diffusion method is shown in Fig. 9. This technique has been applied to particular diseases. Clinical specimens were used to isolate and maintain bacterial strains including E. coli, Staphylococcus aureus, Klebsiella pneumonia, and Bacillus subtilis. According to Assam et al. (2010), activities were classified as resistant if the zone of inhibition was less than 7 mm, moderate if it was between 8 and 10 mm, and sensitive if it was more than 11 mm. The antibacterial activity was increased when using V_2O_5 nanoparticles due to the reduced particle size. When particles are shrunk to the nanoscale, they can easily interface with the surface of bacterial cells and enter the cell without any difficulty. The samples formed a minimal inhibition zone (8mm) in diameter against Staphylococcus aureus and Bacillus subtitles. Hence, from the antibacterial test, it is clear that the sample is found to be more sensitive to the bacteria, thus demonstrating its antibacterial activity. The results were obtained by Assam et al[53]. The Table lists





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the zones of inhibition the samples formed against gram-positive and gram-negative microorganisms. Since it has minimal negative effects, Basillus subtillis is a good bacteria. However, there may be some adverse effects. It can occasionally have an impact on the rhizosphere's helpful bacteria. Then, to reduce the negative effects, V_2O_5 powder is administered.

CONCLUSION

The vanadium pentoxide nanoparticles were produced hydrothermally and annealed at temperatures between 400° C and 600° C. Using the XRD analysis technique, crystal size and orthorhombic structure were studied. By using FESEM and EDX, the surface morphology of nanoparticles and elements was identified. UV-Vis and luminescence validated the optical characteristics. Thermal analysis of TGA and DTA confirmed the endothermic reaction. The use of V_2O_5 nanoparticles increased the antibacterial activity due to the reduced particle size. The samples produced a minimum zone of inhibition of 8mm for Bacillus subtilis and Staphylococcus aureus. Therefore, it is clear from the antibacterial test that the sample is found to be susceptible to bacterial infections showing its antibacterial activity.

DECLARATIONS

All authors have no conflict of interest and agreed to submit the manuscript.

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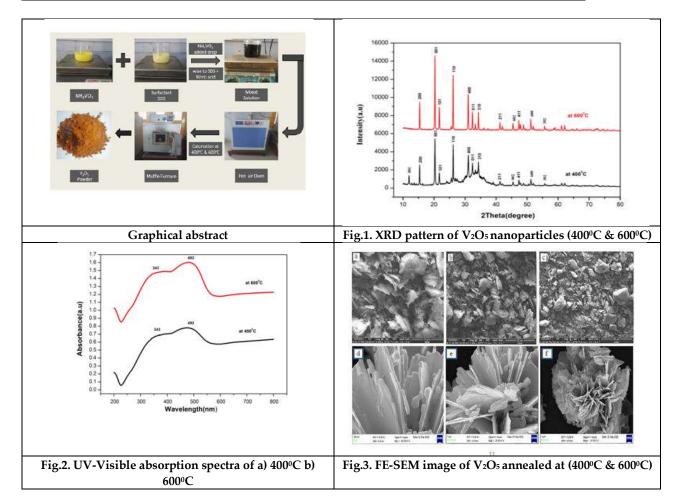




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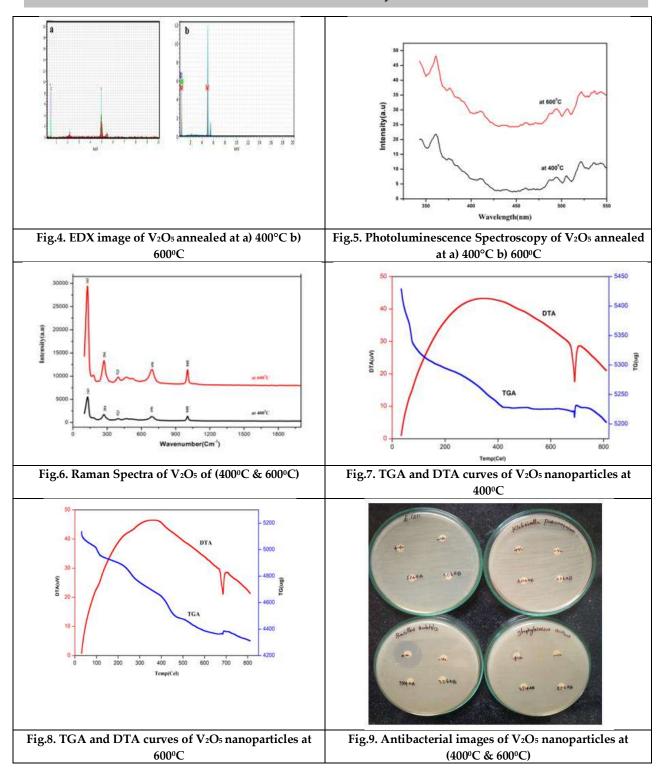
Table.1. Anti-bacterial potential of aqueous extract of SD4AB (400°C) and SD6AB (600°C)

Bacterial Strains	Bacteria Strains Name and Zone of inhibition (mm in diameter)						
bacteriai Strains	SD4AB (400°C)	SD6AB (600°C)	Positive Control	Negative Control			
Staphylococcus aureus (G+)	8	8	10	-			
Bacillus subtilis (G+)	-	8	15	-			
Klebsiellapneumoniae (G-)	-	-	-	-			
E.coli (G-)	9	-	-	-			













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RESEARCH ARTICLE

Simultaneous Estimation of Silymarin and Berberine in Marketed Herbal Formulation by UV Spectroscopy

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ABSTRACT

A new, simple, rapid, and novel UV- spectrophotometric method has been developed and validated for the simultaneous estimation of Silymarin and Berberine. The method involved measurement of absorbance at wavelengths 288 nm and 345 nm. When the marketed formulation was analyzed by the developed method, the % drug contents were found to be 82±1.170% w/w Silymarin and 95±0.89087% w/w Berberine. The developed method was validated for linearity range, detection and quantitation limit, accuracy, precision, robustness, solution stability, and specificity as per ICH guidelines. Linearity was observed in the concentration range of 4-8 µg/ml of Silymarin and 8-16 µg/ml of Berberine, with correlation coefficient values of 0.9842 and 0.9848. Detection and quantitation limits were found to be 0.01040and 0.0315 µg/ml for Silymarin and 0.04326and 0.1311 µg/ml for Berberine respectively. The % drug recovery was found to be near 80% for Silymarin and 95%w/w for Berberine confirming the accuracy of the method. In the case of precision studies, % RSD values were found to be less than two indicating the method was precise. The % RSD values of deliberate variations like ±1nm were found to be less than two showing that the method is robust. The proposed method was recommended for routine analysis since it is rapid, simple, accurate, precise, robust, and stable.

Keywords: UV spectroscopy, Silymarin, Berberine, Method development, Method validation.





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INTRODUCTION

Silymarin is the flavonolignans in the form of a standardized extract prepared from milk thistle (Silybum marinum) Asteraceae fruits (Doodhpatra) and is widely used as a hepatoprotective agent. Silymarin, which is a standardized dry extract containing mainly flavonolignans namely silybin (silibinin) A, silybin (silibinin) B, isosilybin (isosilibinin) A, isosilybin (isosilibinin) B, silychristin (silicristin), and silydianin(Fig1). Currently, S. marianum extracts (usually standardized to contain 70% silymarin) are widely used in supporting liver health and for hepatic disorders. S. marianum extracts exert beneficial properties in a wide variety of other disorders, such as renal protection, hypolipidemic and antiatherosclerosis activities, cardiovascular protection, and prevention of insulin resistance, especially in cirrhotic patients, cancer, and Alzheimer's prevention. The average adult dose of powdered seed is 12-15 g/day; as dry standardized dry extract (silymarin): 200-400 mg/day; and as liquid seed extract: 4-9 mL/day.[1] Berberis aristata, locally known as Daruharidra (Family Berberidaceae), is a very important medicinal plant. Berberineis the active constituent of B. aristata, which is chiefly found in the outer barks of the stem and root of the plant. Berberine is a quaternary ammonium salt from the protoberberine group of benzylisoquinoline alkaloids(Fig 2). Berberine hydrochloride or sulfate is considered a very effective herbal treatment. Berberine is traditionally used in Ayurvedic and Chinese medicine for antimicrobial and antiprotozoal activities. Recent researches have clearly shown that berberine possesses various pharmacological activities that have applications in wide spectrum of therapeutic areas; cancer, diabetes, depression, cardiovascular, and hypertension are some of the areas where berberine has shown enormous potential. Researches on cancer and diabetes suggest that berberine has a definite potential as a drug. Besides, berberine has also shown protective effect in Alzheimer's, cerebral ischemia, and schizophrenia. Berberine in very large doses for more than 4-6 weeks may cause liver overload. Berberine is not advised for use during pregnancy.[2] A literature survey showed that there are manyanalytical methods available for the analysis of Silymarin and Berberine mainly by UV [3,4], HPLC [5-22], HPTLC [23-27], and MS [28-30]. They are also estimated by the hyphenated technique [31-36]. There is no single analytical method for the simultaneous estimation of Silymarin and Berberine.

MATERIALS AND METHODS

Materials

Pure samples of Silymarin and Berberine were kindly supplied from Yucca Enterprises, Mumbai. All reagents used were of analytical grade. The formulation used for analysis was Healthy Hey Nutrition Berberine 95% with Milk Thistle 80% Vegetable Capsules, 60 Count.

Instrumentation

All the weighing were done on an electronic balance (Shimadzu model AUX 220) and an Ultra Sonicator was used for sonication. A LabIndia UV-VIS Spectrophotometer 3200 (UV-Probe 2.21) with a 1.0 cm matched quartz cell was used for all spectral measurements.

Method Development

Selection of solvents

As per the solubility criteria of Silymarin and Berberine, Methanol was selected for analysis (stock), further dilutions from the stock solution were made with methanol, and the last dilution was made with distilled water.

Preparation of standard stock and working standard solutions

10mg of Silymarin was weighed and dissolved in 10 ml of methanol to make 1000 μ g/ml of stock solution. To make 100 μ g/ml solutions, 1 ml of the above stock solution was diluted to 10 ml using methanol. The solutions were further diluted with distilled water to achieve the required concentrations of wavelength ranges (4-8) μ g/ml.





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10mg of Berberine was weighed and dissolved in up to 10 ml of methanol to make 1000 μ g/ml of stock solution. From this stock 1 ml is diluted with methanol up to 10 ml to get 100 μ g/ml. Further dilutions are made from 100 μ g/ml of stock solution and diluted with distilled water up to mark 10 ml to achieve concentrations in the range of (8,10,12,14 and 16) μ g/ml.

Determination of Wavelength

Using distilled water as a blank, a solution of 5 μ g/ml of Silymarin and 10 μ g/ml of Berberine were scanned in the region of 200-400 nm individually. From the overlain spectra of all above shown in Fig no.3, 285 nm wavelength is selected for Silymarin and 345 nm for Berberine.

Determination of absorptivity values

From the absorbance and concentrations of Silymarin(4-8 μ g/ml) and Berberine(8-16 μ g/ml) absorptivity values (a) were determined at λ_{max} of 285 and 345.

Analysis of Marketed Formulation

In a 10 ml volumetric flask, an accurately weighed amount of Capsule, equivalent to 10 mg of Berberine and 5 mg of Silymarin was transferred. A small amount of Methanol was added to the above volumetric flask and the mixture was sonicated for 15 min. The volume was made up to the mark with Methanol. This solution was filtered through Whatman filter paper no 41. Then 1 ml from the above stock solution was pipette out and volume was made with methanol to achieve 100 μ g/ml. 0.5 ml and 1 ml from this stock were piped out and volume was made up with distilled water to achieve 5 μ g/ml of Silymarin and 10 μ g/ml of Berberine. The solution was then analyzed using a newly developed UV-visible spectroscopy method, with the results expressed as a % of drug content.

Method Validation

The UV method was validated for parameters like linearity, accuracy, precision, specificity, and robustness. The method was validated as per ICH guidelines i.e. ICH Q2(R1).

Linearity and Range

The linear relationship between absorbance and concentration of the drugs was evaluated in three replicates over the concentration range of 4-8 μ g/ml of Silymarin and 8-16 μ g/ml of Berberineas a mixture at selected wavelengths. The calibration curves were plotted, regression equation and R^2 values were reported.

Detection and Quantitation Limit

The LOD and LOQ were calculated by the use of the following equation, LOD=3.3 σ / s LOQ=10 σ / s Where, SD = Standard deviation of peak areas of the drug (n=3) and S = Slope of the corresponding calibration plot.

Accuracy

Recovery studies were carried out by preparing synthetic mixtures of the product components containing known quantities of drugs at different levels (50%, 100%, and 150%). The resultant samples were analyzed by the developed method in triplicate readings. The % recovery and amount of drug were reported.

Precision

The sample solution containing 5 μ g/ml of Silymarin and 10 μ g/ml of Berberine was analyzed in six replicates on the same day for repeatability and three successive days in triplicates for intermediate precision. The results were reported as in %Drug Content, SD and % RSD.





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Robustness

The robustness was carried out to evaluate the influence of a small but deliberate variation in the spectrometric condition for the determination of Berberine and Silymarin in the capsule dosage form. The sample solution containing 5 μ g/ml of Silymarin and 10 μ g/ml of Berberine was analyzed in the wavelength of detections (±1nm from their λ max).

Specificity

Specificity is to provide an exact result that allows an accurate statement of the content or potency of the analyte in a sample. The prepared standard mixture and sample solution containing 5 μ g/ml of Silymarin and 10 μ g/ml of Berberine was analyzed for specificity by overlay method.

Stability

The prepared standard and sample solutions containing 5 μ g/ml of Silymarin and 10 μ g/ml of Berberine were found to be stable for 1 day.

RESULTS AND DISCUSSION

Method Development

Selection of wavelength and method of analysis

A solution of 5 μ g/ml of Silymarin and 10 μ g/ml of Berberine drug were scanned in the range of 200-400 nm separately using distilled water as a blank. The wavelengths corresponding to maximum absorbance were noted at 285 nm λ_{max} of Silymarin and 345 nm λ_{max} of Berberine respectively. From the below overlay spectrum,the simultaneous equation method was chosen for analysis (Fig 3).

Determination of absorptivity values

From the absorbance and concentrations of Silymarin and Berberine absorptivity values (a) were determined. The values were found to be ($a_{x1}=0.0618$, $a_{x2}=0.0214$, $a_{y1}=0.056$, $a_{y2}=0.084$)

Analysis of Marketed Formulation

The capsule sample solution was subjected to analysis by the simultaneous equation method. The absorbance of sample solutions was recorded at 285 nm and 345 nm and the concentration of two drugs in the sample was determined by using equations 1 & 2.

Equation 1: simultaneous equation for the estimation of Silymarin

 $C_x = (A_2 a_{y1} - A_1 a_{y2})/(a_{x2} a_{y1} - a_{x1} a_{y2})$

Equation 2: simultaneous equation for the estimation of Berberine

 $C_y = (A_1 a_{x2} - A_2 a_{x1})/(a_{x2} a_{y1} - a_{x1} a_{y2})$

Where: a_{x1} = absorptivity of Silymarin at 285 nm

 a_{x2} = absorptivity of Silymarin at 345 nm

a_{y1} = absorptivity of Berberine at 285 nm

ay2 = absorptivity of Berberine at 345 nm

A1 and A2 are the absorbance of diluted samples at 285 nm and 345 nm respectively.

The % drug content was found to be 82 ± 1.170565 % w/w and 95 ± 0.89087 % w/w for Silymarin and Berberine respectively (Table 1).

Method validation

Linearity and Range

The linear relation for Silymarin and Berberine was found in the range of 4-8 and 8-16 ($\mu g/ml$) respectively. The graph of concentration Vs absorbance was plotted (Fig 4 & 5). A well-correlated linear fit graph was observed for





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both the drugs in the concentration range studied. The linearity results are shown in (Table 2). Fig 6 shows an overlay of linearity for the physical mixture.

Accuracy

Recovery studies performed the accuracy of the proposed method. The amount of drug added and percentage recovery was calculated. The value of % drug content was found in between 80-82% w/w for Silymarin and 92-99% w/w for Berberine and values of % RSD were found to be less than 2 conforming accuracy of the method (Table 3).

Precision

Results of repeatability and intermediate precision studies were estimated in terms of % drug content, SD, and % RSD. Percentage RSD values were found to be 1.74699 and 1.90336 for Silymarin; and 1.68856 and 1.60025 for Berberine for interday and intraday precision, respectively (Table 4), confirming that the precision of the method was acceptable.

Robustness

The Robustness data for variations in the wavelength of detections (±1nm) and the absorbance and analytical performance parameters of Silymarin and Berberine are shown in Table 5.

Specificity

The drugs Silymarin and Berberine in the formulation were accurately quantified (fig 7) using the developed method indicating that there was no interference from commonly present excipients and additives.

Stability

The prepared standard and sample solutions were found to be stable for 16 hours.

CONCLUSION

The UV method for the simultaneous analysis of Silymarin and Berberine in a combined dosage form has not yet been reported scientifically. The proposed method was accurate, precise, and consistent for the determination of Silymarin and Berberine in Marketed Formulation. This method was validated as per ICH guidelines. Results suggest that this method can be used for routine simultaneous estimation of Silymarin and Berberine in Capsule dosage form.

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Table 1: Assay results for Silymarin and Berberine Capsule

Drug	Brand Name	Label Claim	Conc. Prepared	Amount found (µg/ml)	% Assay	SD	%RSD
Silymarin	Berberis Berberine 95% with	250 mg	5 μg/ml	3.696	82.14	1.170565	1.42499
Berberine	Milk Thistle 80% Vegetable Capsules	500 mg	10 μg/ml	9.033	95.08	0.89087	0.93688

Table 2: Linearity results for simultaneous equation method

Parameters	At 285 nm of Silymarin	At 345 nm of Berberine
Linearity range (µg/ml)	4-8	8-16
Regression equation	Y= 4.537x-0.2282	Y= 5.204x-0.246
Correlation coefficient (R2)	0.9842	0.9845
LOD	0.01040	0.04326
LOQ	0.0315	0.1311

Table 3: Recovery results for Silymarin and Berberine

Wavelength		Silymarin	ı	Berberine		
Wavelengin		285 nm		345 nm		
% Recovery Level	50 %	100 %	150 %	50 %	100 %	150 %
Amt. added (µg/ml)	4	5	6	8	10	12
Avg. drug content recovered (µg/ml)	2.825	3.701	4.299	7.492	8.934	10.68
Avg. % recovery	78.48	82.26	79.61	98.57	94.04	92.13
SD of drug content recovered	0.03787	0.05558	0.07867	0.07817	0.059147	0.05022
% RSD of drug content recovered	1.34	1.50	1.83	1.04	0.66	0.46

Table 4: Precision result

Parameter	Silyn	narin	Berberine			
rarameter	Intraday(n=6)	Interday(n=3)	Intraday(n=6)	Interday(n=3)		
% Drug Content	81.6466	82.4544	95.2035	95.0503		
SD	1.554028	1.440468	1.523489	1.604985		
%RSD	1.90336	1.74699	1.60025	1.68856		

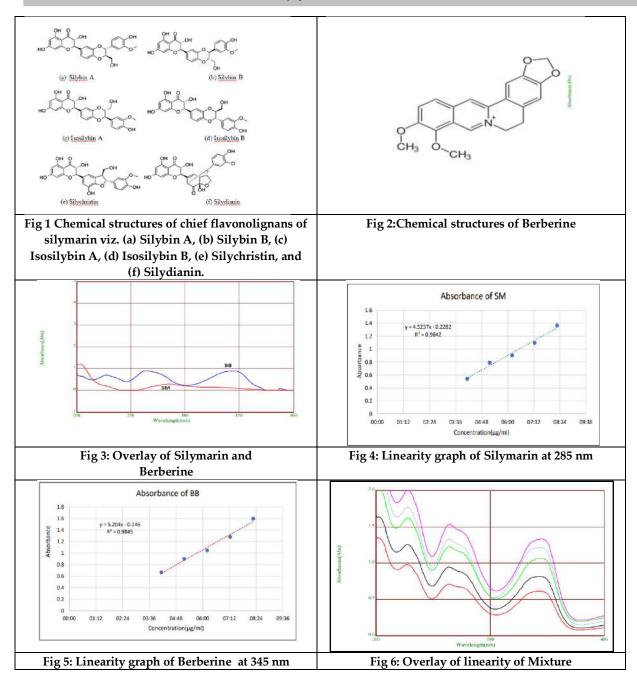
Table 5: Robustness Studies of Capsules for SM and BB

	Silymarin			Berberine		
Wavelength	284	285	286	344	345	346
Avg. % drug content	84.106	82.7871	79.6631	98.152	94.9155	95.965
± SD	1.334291	1.190282	1.098078	0.516201	1.004694	1.068696
% RSD	1.58644	1.43776	1.3784	0.52592	1.05851	1.11363





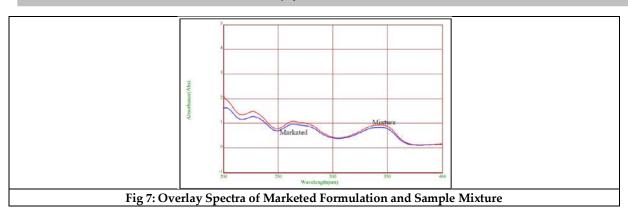
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RESEARCH ARTICLE

Size-Biased Juchez Distribution with its Properties and Applications of **Real Life Datasets**

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ABSTRACT

In this article, we proposed a new probability distribution called size-biased Juchez distribution which is an extension of Juchez distribution. We have derived p.d.f. and c.d.f. of this distribution. Also, we derived the structural properties of size-biased Juchez distribution and the unknown parameter was estimated by maximum likelihood estimator and tested by likelihood ratio test. Finally, we emphasized the real lifetime data sets to reveal how the proposed distribution worked in it.

Keywords: Probability distribution function, Size-biased distribution, Juchez distribution, Moments, Maximum likelihood Estimator, Likelihood ratio test.

INTRODUCTION

The concept of weighted distribution was first proposed by Sir Ronald Aylmer Fisher (1934). The postulate of weighted distribution is an assemblage of model specification and data interpretation. Also, the notion of weighted distribution can be traced to the probe of "the estimation of frequencies based on the effective methods of ascertainment". Then, it was expanded by Rao (1965), as the weighted distribution were applied in many fields like medicine, reliability, ecology, behavioral sciences, finance, insurance, etc. for the development of statistical models. The size-biased distribution was acknowledged independently by Van Deusen (1986). The unit sample is selected with probability which is proportional to any unit size measure is called the size-biased Distribution. It also has applications in medical, social science, environment, econometrics, demography, ecology, geology, forestry, etc. in (2003), Gove. J.H explained the importance of size-biased distribution and also explained its use in forestry field. Lindley distribution by Ghitany. M.E., Atieh.B. and Nadarajah. S.(2008) is formed using exponential with scale





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parameter θ and a gamma distribution having shape parameter 2 and scale parameter θ , $p = \frac{\theta}{\theta+1}$ and the statistical properties like moments, reliability analysis, maximum likelihood estimation of parameters and entropies are discussed. Ghitany. M.E. and Al-Mutaini. D.K. (2008) have estimated the parameter of the size-biased Poisson-Lindley distribution by two estimating methods namely method of moments and maximum likelihood estimators and compared these two estimators. The characterization of the size-biased Poisson-distribution is studied using recurrence relation by Mir. K.A.(2008). Also, he compared the three different estimation methods by using R-software. In (2009), Mir. K. A. and Ahmad. M. described how size-biased distribution theory is useful in real life data.

A special case of the weighted exponential distribution called a size-biased exponential distribution was obtained and estimated its parameters by method of moments, maximum likelihood estimator and Bayesian estimation by Mir. K.A, Ahmed. A. and Reshi. J. A. in (2013). Arooj Ayesha in (2017) introduced a new size-biased Lindley distribution and discussed its properties such as moment measure of skewness, kurtosis, moment generating function, characteristic function, co-efficientof variation, survival and hazard functions. A size-biased Poisson Shanker distribution was proposed by Rama Shanker in (2017) and discussed its structural properties. The parameter is estimated and also discussed the goodness of fit with two real data sets. Shukla. K. K. and Shanker. R.in (2021) introduced a new extension of Poisson-Ishita distribution as size-biased Poisson-Ishita distribution and derived its various statistical properties, Also, they estimated the parameters and compared the size-biased Poisson-Ishita distribution by using the thunder storm events data set.

Size-biased Juchez Distribution (SBJD)

Juchez probability distribution with one parameter was proposed by Udochukwu. V.E. and Julian. I.M. (2022) [10]. This distribution is a combination of two distributions, the exponential distribution and the gamma distribution, with appropriate parameters including a fixed parameter λ and two shape parameters $\alpha = 2$, $\alpha = 4$. Then, the probability distribution function (p.d.f.) and cumulative distribution function (c.d.f.) of this distribution is given by

$$f_{JD}(z,\lambda) = \frac{\lambda^4}{\lambda^3 + \lambda^2 + 6} (1 + z + z^3) e^{-\lambda z}; x > 0, \lambda > 0$$
(2.1)

$$F_{JD}(z,\lambda) = 1 - \left[1 + \frac{\lambda z(\lambda^2 + \lambda^2 z^2 + 3\lambda z + 6)}{\lambda^3 + \lambda^2 + 6} \right] e^{-\lambda z} ; x > 0, \theta > 0$$
 (2.2)

We know that, the p.d.f. of the weighted distribution is

$$f_w(x) = \frac{w(x)f(x)}{E(w(x))}; x > 0$$
 (2.3)

where w(x) be a non-negative weight function and $E(w(x)) = \int_0^\infty w(x) f(x) dx < \infty$. $w(x) = x^c$.

$$f_w(x) = \frac{x^c f(x)}{E(X^c)}; x > 0$$
 (2.4)

where, $E(X^c) = \int_0^\infty x^c f(x) dx$

For size-biased function, put c=1 in x^c ,

$$f_{SB}(x) = \frac{xf(x)}{E(X)}; x > 0$$
 (2.5)

where,





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$$E(X) = \int_0^\infty x f(x) dx \tag{2.6}$$

substitute (2.1) in (2.6), we get,

$$E(Z) = \frac{\lambda^4}{\lambda^3 + \lambda^2 + 6} \int_{-\infty}^{0} z(1 + z + z^3) e^{-\lambda z} dz$$

$$E(Z) = \frac{\lambda^4}{\lambda^3 + \lambda^2 + 6} \left[\int_{\infty}^{0} z \, e^{-\lambda z} \, dz + \int_{\infty}^{0} z^2 \, e^{-\lambda z} \, dz + \int_{\infty}^{0} z^4 \, e^{-\lambda z} \, dz \right]$$

$$E(Z) = \frac{\lambda^3 + 2\lambda^2 + 24}{\lambda(\lambda^3 + \lambda^2 + 6)}$$
(2.7)

By substituting (2.1) and (2.7) in (2.5), then the p.d.f. of the size-biased Juchez distribution (SBJD) is

$$f_{SBJD}(z;\lambda) = \frac{\lambda^5}{\lambda^3 + 2\lambda^2 + 24} (z + z^2 + z^4) e^{-\lambda z}; z > 0; \lambda > 0$$
(2.8)

Then, the cumulative density function (c.d.f.) of the size-biased Juchez distribution (SBJD) is derived as

$$F_{SBJD}(z;\lambda) = \int_0^\infty f_{SBJD}(z;\lambda)dz$$

$$F_{SBJD}(z;\lambda) = \frac{\lambda^5}{\lambda^3 + 2\lambda^2 + 24} \int_{-\infty}^{0} (z + z^2 + z^4) e^{-\lambda z} dz$$

$$F_{SBJD}(z;\lambda) = \frac{1}{13 + 21^2 + 24} [\lambda^3 \gamma(2,\lambda z) + \lambda^2 \gamma(3,\lambda z) + \gamma(5,\lambda z)]$$
 (2.9)

The graphical representations of p.d.f and c.d.f. of the size-biased Juchez distribution (SBJD) are shown below:

Moments

The moments of size-biased Juchez distribution (SBJD) havebeen derived to describe the characteristic of the proposed model. Then, the r^{th} order moment $E(Z^r)$ of size-biased Juchez distribution (SBJD)is derived as

$$\mu_{r}^{'} = E(Z^{r}) = \int_{0}^{\infty} z^{r} f_{SBJD}(z; \lambda) dz$$

$$\mu_{r}^{'} = \frac{\lambda^{5}}{\lambda^{3} + 2\lambda^{2} + 24} \int_{0}^{\infty} z^{r} \cdot z(1 + z + z^{3}) e^{-\lambda z} dz$$

$$\mu_r' = \frac{\lambda^5}{\lambda^3 + 2\lambda^2 + 24} \int_0^\infty z^{r+1} (1 + z + z^3) e^{-\lambda z} dz$$

$$\mu_r = \frac{\lambda^3 \Gamma(r+2) + \lambda^2 \Gamma(r+3) + \Gamma(r+5)}{\lambda^r (\lambda^3 + 2\lambda^2 + 24)}$$
(3.1)





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In equation [3.1], when r=1, the mean of size-biased Juchez distribution (SBJD) which is given by

$$\mu'_1 = E(z) = \frac{\lambda^3 \Gamma(3) + \lambda^2 \Gamma(4) + \Gamma(6)}{\lambda(\lambda^3 + 2\lambda^2 + 24)}$$

$$\mu_{1}^{'} = \frac{2(\lambda^{3} + 3\lambda^{2} + 60)}{\lambda(\lambda^{3} + 2\lambda^{2} + 24)}$$

Similarly, when r=2, 3, 4 in equation (3.1), we will get,

$$\mu_{2}^{'} = E(Z^{2}) = \frac{\lambda^{3}\Gamma(4) + \lambda^{2}\Gamma(5) + \Gamma(7)}{\lambda^{2}(\lambda^{3} + 2\lambda^{2} + 24)}$$

$$\mu_{2}^{'} = \frac{6(\lambda^{3} + 4\lambda^{2} + 120)}{\lambda^{2}(\lambda^{3} + 2\lambda^{2} + 24)}$$

$$\mu_{3}^{'} = E(Z^{3}) = \frac{\lambda^{3}\Gamma(5) + \lambda^{2}\Gamma(6) + \Gamma(8)}{\lambda^{3}(\lambda^{3} + 2\lambda^{2} + 24)} = \frac{24(\lambda^{3} + 5\lambda^{2} + 210)}{\lambda^{3}(\lambda^{3} + 2\lambda^{2} + 24)}$$

$$\mu_{4}^{'} = E(Z^{4}) = \frac{\lambda^{3}\Gamma(6) + \lambda^{2}\Gamma(7) + \Gamma(9)}{\lambda^{4}(\lambda^{3} + 2\lambda^{2} + 24)} = \frac{120(\lambda^{3} + 6\lambda^{2} + 336)}{\lambda^{4}(\lambda^{3} + 2\lambda^{2} + 24)}$$

The central moments about the mean of this distribution are given as

$$\mu_0 = \mu_0' = 1$$

$$u_1 = 0$$

$$\mu_2 = \mu_2' - (\mu_1')^2 = \frac{6(\lambda^3 + 4\lambda^2 + 120)}{\lambda^2(\lambda^3 + 2\lambda^2 + 24)} - \left(\frac{2(\lambda^3 + 3\lambda^2 + 60)}{\lambda(\lambda^3 + 2\lambda^2 + 24)}\right)^2$$

Therefore, the variance of size-biased Juchez distribution (SBJD) is

$$\mu_2 = \frac{2(\lambda^6 + 6\lambda^5 + 6\lambda^4 + 192\lambda^3 + 288\lambda^2 + 1440)}{\lambda^2(\lambda^3 + 2\lambda^2 + 24)^2}$$

$$\mu_3 = \mu_3' - 3\mu_1'\mu_2' + 2\mu_1'^3$$

$$\mu_3 = \frac{4(\lambda^9 + 9\lambda^8 + 18\lambda^7 + 444\lambda^6 + 1224\lambda^5 + 1008\lambda^4 + 3456\lambda^3 + 1140\lambda^2 + 34560)}{\lambda^3(\lambda^3 + 2\lambda^2 + 24)^3}$$

The standard deviation (σ), co-efficient of variation (C.V.) and index of dispersion (γ) of size-biased Juchez distribution (SBJD) are obtained as

$$\sigma = \frac{\sqrt{2(\lambda^6 + 6\lambda^5 + 6\lambda^4 + 192\lambda^3 + 288\lambda^2 + 1440)}}{\lambda(\lambda^3 + 2\lambda^2 + 24)}$$

$$C.V. = \frac{\sigma}{\mu_1} = \frac{\sqrt{2(\lambda^6 + 6\lambda^5 + 6\lambda^4 + 192\lambda^3 + 288\lambda^2 + 1440)}}{2(\lambda^3 + 3\lambda^2 + 60)}$$





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$$\gamma = \frac{\sigma^2}{\mu_1^{'}} = \frac{\lambda^6 + 6\lambda^5 + 6\lambda^4 + 192\lambda^3 + 288\lambda^2 + 1440}{\lambda^3 + 3\lambda^2 + 60}$$

The graphical representation of Co-efficient of Variation (C.V.) and Index of Dispersion of the size-biased Juchez distribution (SBJD) are shown below:

Survival Analysis

Survival Function

The survival function of the size-biased Juchez distribution (SBJD) is given by

$$S(z) = 1 - F(z)$$

$$S(z) = 1 - \frac{\left[\lambda^3 \gamma(2, \lambda z) + \lambda^2 \gamma(3, \lambda z) + \gamma(5, \lambda z)\right]}{\lambda^3 + 2\lambda^2 + 24}$$

Hazard Function

The hazard function is also known as the hazard rate, instantaneous failure rate or force of mortality of the size-biased Juchez distribution (SBJD) is given by

$$h(z) = \frac{f_{SBJD}(z;\lambda)}{1 - F_{SBJD}(z;\lambda)}$$

$$h(z) = \frac{\lambda^5 (z + z^2 + z^4)e^{-\lambda z}}{(\lambda^3 + 2\lambda^2 + 24) - [\lambda^3 \gamma(2,\lambda z) + \lambda^2 \gamma(3,\lambda z) + \gamma(5,\lambda z)]}$$

Reverse Hazard Function

The reverse hazard function or reverse hazard rate of the size-biased Juchez distribution (SBJD) is given by

$$h_r(z) = \frac{f_{ABSD}(z;\lambda)}{F_{ABSD}(z;\lambda)}$$

$$h_r(y) = \frac{\lambda^5(z+z^2+z^4)e^{-\lambda z}}{[\lambda^3\gamma(z,\lambda z)+\lambda^2\gamma(3,\lambda z)+\gamma(5,\lambda z)]}$$

Mills Ratio

The Mills ratio of the size-biased Juchez distribution (SBJD) is Mills Ratio =
$$\frac{1}{h_r(z)} = \frac{[\lambda^3 \gamma(2,\lambda z) + \lambda^2 \gamma(3,\lambda z) + \gamma(5,\lambda z)]}{\lambda^5 (z+z^2+z^4)e^{-\lambda z}}$$

Moment Generating Function and Characteristic Function

Assume Z have a Size-biased Juchez distribution (SBJD), we will get the moment generating function of Z as

$$M_z(t) = E(e^{tz}) = \int_0^\infty e^{tz} f_{SBJD}(z; \lambda) dz$$

Using Taylor's expansion,

$$M_{z}(t) = \int_{0}^{\infty} \sum_{j=0}^{\infty} \frac{t^{j}}{j!} z^{j} f_{SBJD}(z; \lambda) dz = \sum_{j=0}^{\infty} \frac{t^{j}}{j!} \mu_{j}'$$

$$M_z(t) = \frac{1}{(\lambda^3 + 2\lambda^2 + 24)} \sum_{i=0}^{\infty} \frac{t^j}{j! \lambda^j} \left(\lambda^3 \Gamma(j+2) + \lambda^2 \Gamma(j+3) + \Gamma(j+5) \right)$$

In the same way, we will get the characteristics function of size-biased Juchez distribution (SBJD)can be obtained as





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$$\varphi_{z}(t) = E[e^{itz}] = \frac{1}{(\lambda^{3} + 2\lambda^{2} + 24)} \sum_{j=0}^{\infty} \frac{(it)^{j}}{j!\lambda^{j}} (\lambda^{3}\Gamma(j+2) + \lambda^{2}\Gamma(j+3) + \Gamma(j+5))$$

Maximum Likelihood Estimator and Fisher Information Matrix

The maximum likelihood estimator is the best numerical stability estimator to estimate the parameters of the distribution when compared with other estimating methods. Thus, we used this method to estimate the parameters of SBJD which is derived below:

Let $Z_{(1)}, Z_{(2)}, \dots, Z_{(n)}$ be the random sample of size n drawn from the SBJD, then, the likelihood function of SBJD is

$$L(z;\lambda) = \prod_{i=1}^{n} f_{SBJD}(z;\lambda) = \prod_{i=1}^{n} \frac{\lambda^{5}}{\lambda^{3} + 2\lambda^{2} + 24} (z + z^{3} + z^{4}) e^{-\lambda z}$$

$$L(z;\lambda) = \frac{\lambda^{5n}}{[\lambda^3 + 2\lambda^2 + 24]^n} \prod_{i=1}^n z_i (z + z_i + z_i^3) e^{-\lambda z_i}$$

The natural log likelihood function is

$$\log L = 3n \log \lambda - n \log(\lambda^3 + 2\lambda^2 + 24) + \sum_{i=1}^{n} \log z_i + \sum_{i=1}^{n} \log(z + z_i + z_i^3) - \lambda \sum_{i=1}^{n} z_i$$
(5.1)

By differentiating equation (5.1) with respect to λ , the maximum likelihood estimates of λ can be attained as

$$\frac{\partial \log L}{\partial \lambda} = \frac{3n}{\lambda} - \frac{\lambda^3}{(\lambda^3 + 2\lambda^2 + 24)} - \sum_{i=1}^n z_i = 0 \tag{5.2}$$

Because of the complicated form of likelihood equation (5.2), algebraically it is very difficult to solve the system of non-linear equation. Therefore, we use R and wolfram Mathematica for estimating the required parameters.

Likelihood ratio Test

This test is used to compare the goodness of fit of the two models based on the ratio of their likelihoods. Suppose $Z_{(1)}$, $Z_{(2)}$,, $Z_{(n)}$ be a random sample from the SBJD. To test, the random sample of size n for SBJD, the hypothesis is

$$H_0: f(z) = f_{ID}(z, \lambda)$$
 agaist $H_1: f(z) = f_{SBID}(z; \lambda)$

To check whether the random sample of size n comes from the Juchez distribution or size-biased Juchez distribution, the likelihood ratio is

$$\Delta = \frac{L_1}{L_0} = \prod_{i=1}^{n} \frac{f_{SBJD}(z; \lambda)}{f_{JD}(z, \lambda)}$$

$$\Delta = \prod_{i=1}^{n} \frac{\lambda(\lambda^3 + \lambda^2 + 6)}{(\lambda^3 + 2\lambda^2 + 24)} z_i = \prod_{i=1}^{n} \frac{\lambda^n (\lambda^3 + \lambda^2 + 6)^n}{(\lambda^3 + 2\lambda^2 + 24)^n} z_i$$

Therefore, the null hypothesis is rejected if

$$\Delta = \left[\frac{\lambda(\lambda^3 + \lambda^2 + 6)}{(\lambda^3 + 2\lambda^2 + 24)} \right]^n \prod_{i=1}^n z_i > k$$





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$$\Delta^* = \prod_{i=1}^n z_i > k^* \ where \ k^* = k \left[\frac{\lambda(\lambda^3 + \lambda^2 + 6)}{(\lambda^3 + 2\lambda^2 + 24)} \right]^n > 0$$

We can conclude, for large sample size n, 2 log is distributed as chi-square distribution with one degree of freedom. Also, p-value is attained from the chi-square distribution. If p ($\Delta^* > k^*$), where $k^* = \prod_{i=1}^n z_i$ is less than the specified level of significance and $\prod_{i=1}^n z_i$ is the observed value of the statistic Δ^* , then, reject null hypothesis.

Order Statistics

Let X_1 , X_2 , X_n be the random variable drawn from the continuous population. Their p.d.f. be $f_x(x)$ and cumulative density function with $F_x(x)$. Then, assume $X_{(1)}, X_{(2)}, \dots, X_{(n)}$ be the order statistics of a random sample.

Thus, the probability density function of r^{th} order statistics $X_{(r)}$ is given by

$$f_{z_{(r)}}(z;\lambda) = \frac{n!}{(n-r)!(r-1)!} f(z) [F(z)]^{r-1} [1 - F(z)]^{n-r}$$
(8.1)

Putting the equation (2.8) and (2.9) in equation (7.1), the probability density function of r^{th} order statistics $Z_{(r)}$ of size-biased Juchez distribution is given by

$$\begin{split} f_{z_{(r)}}(z) &= \frac{n!}{(n-r)! \, (r-1)!} \left\{ \frac{\lambda^5}{\lambda^3 + 2\lambda^2 + 24} (z + z^2 + z^4) e^{-\lambda z} \right\} \mathbf{x} \\ &\left\{ \frac{[\lambda^3 \gamma(2, \lambda z) + \lambda^2 \gamma(3, \lambda z) + \gamma(5, \lambda z)]}{\lambda^3 + 2\lambda^2 + 24} \right\}^{r-1} \mathbf{x} \left\{ -\frac{[\lambda^3 \gamma(2, \lambda z) + \lambda^2 \gamma(3, \lambda z) + \gamma(5, \lambda z)]}{\lambda^3 + 2\lambda^2 + 24} \right\}^{n-r} \end{split}$$

Then, the probability density function of higher order statistics Z(n) can be derived as

$$f_{z_{(n)}}(z;\lambda) = \left\{ \frac{n\lambda^5}{\lambda^3 + 2\lambda^2 + 24} (z + z^2 + z^4) e^{-\lambda z} \right\} \times \left\{ \frac{[\lambda^3 \gamma(2,\lambda z) + \lambda^2 \gamma(3,\lambda z) + \gamma(5,\lambda z)]}{\lambda^3 + 2\lambda^2 + 24} \right\}^{n-1}$$

Hence, the probability density function of 1st order statistics Z(1)can be obtained as

Goodness of Fit

It is a measure to check how a statistical model fits a data set. Here, we will discuss how the proposed model is fit to the two data sets which is illustrated below. Also, compare with Juchez distribution to show better fit of size-biased Juchez distribution. Let us represent the two data sets, which represents the data of average temperature of four cities namely, Gangtok, New Delhi, Kolkata and Mumbai in India from January to December 2022 by Mohammad Bilal Hussain in the website:https://www.kaggle.com/datasets/bilalwaseer/worlds-cities-with-their-average-temperature and the data of Economic Freedom Index Score for Asia-Pacific regions in 2019 by Lewis Duncan in the website:https://www.kaggle.com/datasets/lewisduncan93/the-economic-freedom-index. The data sets are given as follow: In order to compare the distributions, we study the criteria like Akaike Information Criterion (AIC), Akaike Information Corrected (AICC), Bayesian Information Criterion (BIC) and -2 logL. The better distribution is which compatible to lesser values of AIC, BIC, AICC and -2 logL.

CONCLUSION





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In this article, the p.d.f. and c.d.f. of a new model called size-biased Juchez distribution (SBJD) which is a special case of weighted distribution are obtained. The resiliency of the parameter of this distribution makes it to provide a better result. Some statistical properties are very well explained. Its parameter was estimated by maximum likelihood estimator and tested by using the likelihood ratio test. We have This distribution has better compatibility than Juchez distribution in real life time data sets.

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Table 1: Data of Average Temperature of four Cities in India from Jan to Dec 2022

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gangtok	8.5	10	13.3	16.2	17.7	19.2	19.3	19.5	18.7	16.6	13.1	10.1
New Delhi	13.8	16.5	22.1	28.7	32.8	34	30.9	29.7	29	26.1	20.5	15.3
Kolkata	20.1	22.8	27.6	30.5	31.3	30.4	29.1	28.8	28.8	27.5	23.7	20.3
Mumbai	23.7	24.5	26.8	28.4	29.9	29.2	27.6	27.2	27.3	28.3	27.2	25.2

Table 2: Data of Economic Freedom Index Score for Asia-Pacific regions in 2019

Country	Afghanistan	Australia	Azerbaijan	Bangladesh	Bhutan	Brunei	Burma
Name Score	51.5	80.9	65.4	, 0		Darussalam 65.1	53.6
Country Name	Cambodia	China	Hong Kong	India	Indonesia	Japan	Kazakhstan
Score	57.8	58.4	90.2	55.2	65.8	72.1	65.4





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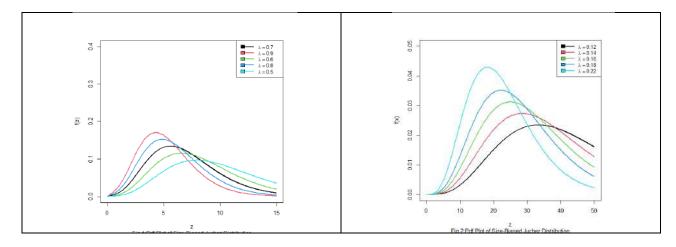
Country Name	Kiribati	Korea, North	Korea, South	Kyrgyz Republic	Laos	Macau	Malaysia
score	47.3	5.9	72.3	62.3	57.4	71	74
Country Name	Maldives	Micronesia	Mongolia	Nepal	Pakistan	Papua New Guinea	Philippines
score	53.2	51.9	55.4	53.8	55	58.4	63.8
Country Name	Samoa	Singapore	Solomon Islands	Sri Lanka	Taiwan	Tajikistan	Thailand
score	62.2	89.4	54.6	56.4	77.3	55.6	68.3
Country Name	Timor-Leste	Tonga	Turkmenistan	Uzbekistan	Vanuatu	Vietnam	
Score	44.2	57.7	48.4	53.3	56.4	55.3	

Table 3:MLE's, -2logL, AIC, BIC and AICC of the size-biased Juchez distribution of data set 1.

Distribution	MLE	S.E	-2logL	AIC	BIC	AICC
Juchez	$\hat{\lambda} = 0.1697326$	0.0117475	369.026	371.026	372.9772	371.1129
Size-biased Juchez	$\hat{\lambda} = 0.2124328$	0.0131613	361.7641	363.7641	365.7153	363.8510

Table 4: MLE's, -2logL, AIC, BIC and AICC of the size-biased Juchez distribution of data set 2.

Distribution	MLE	S.E	-2logL	AIC	BIC	AICC
Juchez	$\hat{\lambda} = 2.0581341$	0.1634039	85.52642	87.52642	89.23999	87.62642
Size-biased Juchez	$\hat{\lambda} = 3.0850397$	0.2171523	62.87354	64.87354	66.58712	64.97354

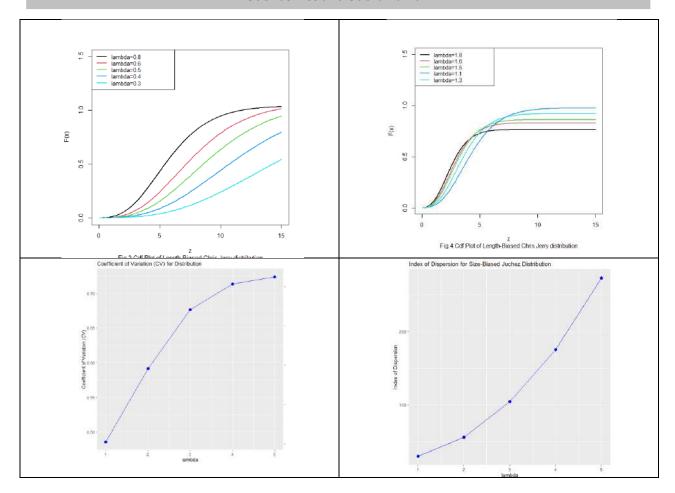






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RESEARCH ARTICLE

A Comparative Study on Antimicrobial, Anticancer Effect of Phyto Lipids and miRNA Extracted from Alpinia calcarata

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ABSTRACT

Cancer is a hereditary disease characterized by anomalies in the structure and expression of coding genes as well as non-coding DNA. miRNA regulates the transcription of many genes and modifies various points in disease pathways. Through examining variations in miRNA expression, research on miRNA and the genes they regulate that are linked to carcinogenesis highlights our understanding of the mRNA regulation mechanism. In the present study, miRNA was isolated to analyze their antimicrobial and anticancer activity. The effect of bioactive substances - Phyto lipids, from the Alpinia calcarata rhizomes were studied. Rhizomes of Alpinia calcarataexhibit antibacterial activity against Streptococcus pneumoniae, Pseudomonas aeruginosa, and E. coli, with an inhibition zone of 0.15 cm, 0.18 cm, 0.22 cm, 0.27 cm, and 0.31 cm for 10µl, 15µl, 20µl, 25µl, and 30µl of lipid extract. These values indicate the plant's potential as an antimicrobial agent. The minimal inhibitory concentration was 10µl of lipid extract for E. Coli and Bacillus subtilis, Staphylococcus aureus 15µl and 20µl for Streptococcus pneumonia. The anticancer properties of miRNA isolated from the plant rhizome were analyzed in MCF-7 breast cell line. The results showed that miRNA had a low effect on cell death, whereas miRNA and lipid produced increased cell death (IC50 values of 43.05 and 47.89, respectively). Preliminary phytochemical analysis by chemical method and analyzed components of the lipid extracts dissolved in chloroform: methanol characterized by FTIR





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produced a molecular spectral fingerprint of the sample representing chemical structures and functional groups.

Keywords: miRNA, sphingolipids, Alpinia calcarata, Oncogene, Breast cancer.

INTRODUCTION

Cancer a genetic disease of cell structural modification, expression abnormalities of coding genes, oncogenes protein and tumor suppressor genes representing cause of tumorigenesis. There is encouraging evidence to suggest that the presence of cancer stem cells (CSCs), a population of cells with the potential to self-renew, and their role in starting tumor growth, sustainability, and differentiation are the cause of cancer recurrence, metastasis, and resistance to anticancer drugs (Dandawateet al. 2016). MCF 7 - human epithelial cells from pleural emanation with receptors of glucocorticoid, estrogen, and progesterone(European collection of authenticated cell cultures) are suitable model cells for invitro study. miRNA - 22nt RNAs present in Eukaryotes, prokaryotes, and some viruses, play major role in gene silencing, post-transcriptional changes, and expression of gene binding to 3' end of untranslated region of mRNA and translate repression directing mRNA cleavage. The miRNA dis-regulation correlates with aggressive division of human cancers, involved in initiation, progression, and mimic oncogenes (OncoMirs) or tumor suppressors (Tus). The miRNAs target identification facilitates new therapeutic strategies, potential diagnostic, and prognostic biomarkers to treat cancers (Yong Peng et.al. 2016). The distorted unique microRNAs subset expression profile in tumor and biological fluids confer an attractive source of specific sensitive biomarkers. MiR 15/16 clusters was either deleted or down regulated in chronic lymphocytic leukemia patients, myriad reports show cancer-associated miRNA signature in neoplastic tissues. Alteration in miRNA allowed accurate malignancy classification and tissue origin identification of poorly differentiated tumors (Leva et.al. 2013). According to traditional medicine, Alpinia calcarata, a perennial herb with branches, has antibacterial, antifungal, anthelmintic, antinociceptive, antioxidant, aphrodisiac, gastroprotective, and anti-diabetic qualities. Its rhizome with light to dark brown in color (Arambewela et.al. 2010).

For the treatment of a variety of respiratory conditions, including bronchitis, cough, respiratory diseases, diabetes, asthma, and arthritis, essential oil, and extracts from Alpinia calcarata have a wide range of biological effects and pharmacological actions (Rahman et al., 2015). The high number of antioxidant substances flavonoids and terpenoids indicate the therapeutic compounds effective for cardiovascular disease and blood pressure (Victoria et.al. 2011). Lipids with carbohydrates and proteins in viable plant and animal cells, insoluble in water can be extracted in organic solvents like ether and chloroform. Sphingolipids and phospholipids function in structural recognition, signal transduction of cancer cell by developing signals that induces differentiation and apoptosis (Brown D.A et al., 2002). Signal transduction increased saturated phospholipids to protect oxidative damage of cancer cells that like lipid peroxidationinhibits the uptake of chemotherapeutic drugs. Lipid homeostasis disruption induce erythrocyte sedimentation rate and apoptosis, where ERS exceed cell's adaptive mechanism, lipid homeostasis and ERS induced apoptosis which are specific in steroidogenic cancer cells (Djefafliaet al. 2016). Link between sphingomyelin metabolism and colon cancer is indicated by an increased S1P/Cer (sphingosine-1-phosphate/ceramide) ration which results in the alterations of several metabolic sphingolipid pathways that contributes to colorectal cancer, by the development through upregulation of gene and/or proliferating tumor cells which simultaneously promotes intestinal inflammation by reducing sensitivity of colorectal cancer to chemotherapy (Miroslav Machala et al., 2019). The present experimental study, the antibacterial and antitumor activities of Alpinia calcaratarhizomes were checked. The lipids and miRNA isolated from the plant rhizome powder were analyzed for their anticancer effect in MCF-7 cell lines. A preliminary phytochemical analysis of lipid extract by biochemical method and FTIR analysis of lipid extract was done.





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MATERIALS AND METHODOLOGY

Collection of samples and preparation

Alpinia calcarata rhizomes obtained from the local garden in Erode, Tamil Nadu, washed with water to remove the soil and dirt, sliced into pieces, dried, and powdered. The fine powder was taken for extraction of total lipids and miRNA.

Extraction of total Phyto lipids (Bligh and Dyer method, 1959)

10g powdered samples of *Alpinia calcarata*in10ml Methanol: Chloroform (2:1) were homogenized and centrifuged for 5 minutes at 3000 rpm. Pellet in thirty millilitres of methanol:c hloroform (2:1) with eight millilitres of 1% KCL was centrifuged for five minutes at 3000 rpm, and the supernatant was centrifuged once more. The lower layer of lipids was dried.

Extraction of miRNA from rhizomes of Alpinia calcarata

10 mg powdered sample homogenized in denaturing buffer, mixed with 200 µl Chloroform for 5 minutes on ice. An equal volume of ice-cold isopropanol separatesaqueous phase of the homogenate on centrifugation for six minutes at 12,000 rpm. 75% ethanol removes nuclease and other degrading molecules from the pellet, air dried, stored at 4 degrees Celsius and quantified using agarose gel electrophoresis.

Antimicrobial screening by Minimal inhibitory concentration of total Phyto lipids extracted from Alpinia calcarata

Bacterial culture inoculated Luria Bertani broth, incubated overnight, and checked for minimal inhibitory concentration. Serially diluted (10^{-1} , 10^{-2} , 10^{-3} , 10^{-4} , 10^{-5}) bacterial culture and concentrations of lipid sample 10μ l, 15μ l, 20μ l, 25μ l, 30μ l incubated in test tubes in a shaker incubator for 24 hours and colorimetric reading plottedfor MIC identification of totallipids.

Antimicrobial susceptibility test of total Phyto lipids extracted from *Alpinia calcarata* (Kirby Bauer disc diffusion method)

The lipid extract of *Alpinia calcarata* isolated by using Bligh and Dyer method (air dried) tested using bacterial species such as *Escherichia coli, Staphylococcus* and *Bacillus* for antimicrobial activity in nutrient agar medium containing 0.5% peptone, 0.8% beef extract, 1.5% agar, and 0.5% sodium chloride. Stock bacterial culture maintained at 4°C on slants, subculture and plateda loopful of bacteria in nutrient broth. Nutrient medium in petri plates equally covered with the bacterial culture and dried lipid extracts (10µl, 15µl, 20µl, 25µl, 30µl) in wells with Amoxylin and Ampicilinantibiotic discas standard on 24 hours of incubation were observed for zone of inhibition.

Phytochemical screening of total Phyto lipid extracted from Alpinia calcarata

Extracts of *Alpinia calcarata* in both ethanol and water were employed for phytochemical analysis. Standard techniques were utilized for the analysis of alkaloids (Mayer's test), saponins (Froth formation test), carbohydrates (Molisch's test), terpenoids, phenols, flavonoids, steroids (Salkowski test), tannins (Ferric chloride test), coumarins, and quinones. (Rohit et al.,2018). The *Alpinia calcarata* lipid extract mixed with two millilitres of concentrated HCL to detect the presence of alkaloids on adding a few drops of Mayer's reagent produced green colour or white precipitate. *Alpinia calcarata* lipid extract (2 millilitres) with 1 millilitre of 2N sodium hydroxide (NaOH) indicates presence offlavonoids with formation of yellow color. Lipid extracts (two millilitres)with one millilitre of sulphuric acid (H2SO4) and two millilitres of chloroform indicative of the presence of steroids forms a reddish-brown ring at the interface. *Alpinia calcarata* lipid extract (2 millilitres) with 1 millilitre of ferric chloride detects tannins forming dark blue or greenish black color. *Alpinia calcarata* ethanol extractmixed with two millilitres of sterile distilled water and a few drops of 10% ferric chloride indicates phenol by their blue or green appearance. Shaking two millilitres of *Alpinia calcarata* ethanolic extract in a graduated cylinder for fifteen minutes and addition of two millilitres of sterile distilled water a layer of foam formedindicated the presence of saponins.





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Fourier Transform Infra-Red Spectrometry analysis of Alpinia calcarata

Fourier transform infrared spectroscopy (FTIR), an effective method for identifying the functional groups linked to the molecular bonds in chemical compounds. Shimadzu model spectrum-I PC instrument model for 500µl of *Alpinia calcarata's* lipid extract in 2:1 ratio of methanol to chloroform at a concentration of 1 mg/ml produced peaks that were characterized. An infrared beam generated and released from a blazing black body source, passed through an interferometer to encrypt spectrum. An interferogram, or constructive and destructive interference, is produced when beams with varying path lengths recombine. The light beam that enters the sample compartment take in the energy frequencies that correspond to the distinct properties of the sample. A beam is overlaid in the instrument operation to provide a reference peak. The detector measures the interferogram signal versus time for all frequencies concurrently. After the interferogram, the desired spectrum will be obtained by using Fourier transformation software to subtract the reference spectrum from the sample spectrum (Mohamed *et al.*, 2017).

Cytotoxicity analysis of total Phytolipids of Alpinia calcarata

MTT assay on MCF-7 cells both pre- and post-treatment with Phytolipid and miRNA converts 2-(4,4-dimethyl-2-tetrazoyl)-2, 5-diphenyl-2, 4-tetrazolium salts into insoluble formazan enzymatically by mitochondrial succinate dehydrogenase of living cells, the total amount of formazan formed is a measure of cell viability; the formazan formed is then solubilized with the appropriate solvents to measure the cell viability in a microtiter plate reader. The MCF 7 cell lines cultured in MEM media containing 10% FBS, trypsinized, and counted in hemocytometer. A 96-well plate of the cells were cultured for a full day replacing used medium with the fresh medium, Samples (Lipid + miRNA and miRNA) were incubated with different concentrations of equal volume (Lipid + miRNA) ($10\mu l$, $15\mu l$, $20\mu l$, $25\mu l$, $30\mu l$) in triplicates. After the initial 18-hour incubation at 37° C, a 1 mg/ml concentration of MTT reagent was added and the mixture incubated for 4 hours. With a photometer, the plate was read at 570 nm. The formula was used to calculate cell viability and cytotoxicity.

Cell viability = (Treated / control) * 100

Cytotoxicity = [(Control - Treated) / Control] *100

RESULT AND DISCUSSION

Extraction of total Phyto lipids (Bligh and Dyer method,)

The total lipid content of 0.34g in 10g of *Alpinia calcarata* indicates extraction efficiency of total 3.4%. The lipid yield extracted with chloroform: methanol (1:2) as solvent is enhanced compared to the previous studies using methyl tertbutyl ether (MTBE): methanol (3:1) (Salem et al.,2016).

Extraction of miRNA from rhizomes of Alpinia calcarata

miRNAisolated from the *Alpinia calcarata* using a denaturing buffer containing urea and sodium acetate and visualization of distinctbands on 1.5% agarose gel viewed under UV Transilluminator indicating presence of miRNA in the sample. The isolation of miRNA from rhizome by non-conventional method (using urea and sodium acetate), a simple and efficient methodcompared to isolation of miRNA by CTAB method (Kiefer E et al.,2000) and LiCl method (Zhu YQ et al.,2013). miRNA quantified and purity checked, a clear band on Lane 7 indicated presence of miRNA in *Alpinia calcarata*.

Antimicrobial screening by Minimal inhibitory concentration of total phytolipids extracted from Alpinia calcarata

Total lipids were isolated from the rhizome and their minimal inhibitory concentration was checked on *Bacillus*, *Escherichia*, *Staphylococcus and Streptococcus* species. The minimal inhibitory concentration of lipid extract for *E. Coli* and *Bacillus subtilis* is 10µl, *Staphylococcus aureus*, 15µl and 20µl for *Streptococcus pneumoniae*.





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Antimicrobial susceptibility test of total Phyto lipids extracted from *Alpinia calcarata* (Kirby Bauer disc diffusion method)

Alpinia calcarata's lipid extract tested for antimicrobial activity against gram-positive bacteria *Pseudomonas aeruginosa* and *Streptococcus pneumonia* and gram-negative bacteria like *E. coli* and *Klebsiella pneumonia* demonstrated the greatest inhibition against *Pseudomonas aeruginosa* and *Streptococcuspneumoniae*.

Fourier Transform Infra-Red Spectrometry analysis of *Alpinia calcarata*lipids. Cytotoxicity analysis of total Phytolipids of *Alpinia calcarata*Anticancer activity of miRNA of *Alpinia calcarata*in MCF 7 cell lines
SUMMARY AND CONCLUSION

Total Phytolipids extracted chloroform: methanol (1:2) by Bligh and Dyer method showed 3.4% inhibition efficiency percentage. miRNA isolated from the Alpinia calcaratabynon-conventional methods and quantified using Agarose gel electrophoresis. Zones of inhibition in gram-positive and gram-negative bacteria 0.15cm, 0.18cm, 0.22cm, 0.27cm, 0.31cm with different concentration of total Phyto lipid extract, Streptococcus pneumoniae had higher susceptibility, organisms Pseudomonas aeruginosa, E. coli, Klebsiella pneumoniaeexhibited little or no effect. The minimal inhibitory concentration of Phytolipids on E. coli and Bacillus subtilis was 10µl, Staphylococcus aureus 15µl and 20µl for Streptococcus pneumoniae. Phytochemical examination oflipid extracts indicated the absence of the alkaloid phenol and presence of tannin, saponin, steroids, and flavonoids. FTIR analysis revealed characteristic peaks of Phytolipids and their functional groups of lipids. The peaks observed were from 550 to 4000 cm⁻¹ confirms the presence of alcohol, carboxylic acid, and methyl group of Phytolipids. MiRNA isolated from Alpinia calcarataare tuber powder on treatment with MCF 7 cell line. however, miRNA with lipid induced increased cell death, a comparison of the IC50 values of sample miRNA with lipid and only miRNA. In the terms of molecular events occurring in tumor, an important hallmark inevasion of apoptosis and tumor progression is deregulation of miRNA. However further works are still needed to formulate dose dependent response and mechanism of action relationship effects. Additional studies in Alpinia could help to assess and understand the means of using this plant in diagnosis or treatment of multi-syndromes in human disease which may include the nanomedicine formulation against several other human and veterinary pathogens, to develop interface studies between biology, material, and structural science.

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Table 1: Zone of inhibition of microorganisms on treatment of lipids extract of *Alpinia calcarata*.

	Consentation		cm		
S.No	Concentration (µg/ml)	Bacillus subtilise	Escherichia coli	Staphylococcus aureus	Streptococcus pneumonia
1	Blank	0.0	0.0	0.0	0.0
2	10	0.30	-	0.48	0.45





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3	15	0.39	-	0.41	0.43
4	20	0.46	-	0.44	0.41
5	25	0.45	-	0.48	0.54
6	30	0.40	-	0.54	0.57

Table 2: Antimicrobial activity checked by well diffusion method indicated zone of inhibition 0.15cm, 0.18cm, 0.22cm, 0.27cm, 0.31cm for 10µl, 20µl, 25µl, 25µl and 30µl of lipid extract using *Streptococcus pneumoniae* (B) whereas other organisms *Pseudomonas aeruginosa* (A), E. coli (D), Klebsiella pneumoniae (C)showed little or no effect for lipid extract of *Alpinia calcarata*.

Concentration	5µl	10µl	15µl	20µl	25µl
A	0.1 cm	0.14 cm	0.2 cm	0.29 cm	0.32 cm
В	0.15 cm	0.18 cm	0.22 cm	0.27 cm	0.31 cm
С	0	0	0	0	0
D	0	0	0	0	0

Table 3: Phytochemical screening of ethanolic extract of *Alpinia calcarata*.

S No	Phytochemical test	Observation	Results
1	Alkaloid	Absence of white and green color	
2	Flavonoid	Appearance of yellow color	+++
3	Steroid	Appearance of reddish-brown color	+++
4	Tannin	Appearance of greenish blue color	+++
5	Phenol	Absence of green color	_
6	Saponin	Presence of foam	+++

Table 4: IR Frequency table

Table 4: IX Frequency table							
Frequency range	Absorption	Appearance	Group	Compound class			
4000 20001	2924.09	Characa lamas d	O-H	المناه ما المالية المالية المالية المالية المالية المالية المالية المالية المالية المالية المالية المالية المالية			
4000-3000 cm ⁻¹	2924.09	Strong, broad	stretching	Carboxylic acid			
		TA7 1 1 1	О-Н	A1 1 1			
		Weak, broad	stretching	Alcohol			
		Cı 1 1	N-H	A ' 11			
		Strong, broad	stretching	Amine salt			
1000-650 cm ⁻¹	817.82	Chrono	C-Cl	Halo			
1000-650 CIII 1	017.02	Strong	stretching	compound			
		Medium	C=C bending	Alkene			
1000 (50 1	601.79	Strong	C-Br	II-11			
1000-650 cm ⁻¹			stretching	Halo compound			
	555.50	Strong	C-l stretching	Halo compound			
4000-3000 cm ⁻¹	3294.42	Chroma broad	О-Н	Alcohol			
4000-3000 CIII 1	3294.42	Strong, broad	stretching	Alcohol			
1400-1000 cm ⁻¹	1033.85	Chuana	C-O	Aromatic ester			
1400-1000 CIII -	1033.63	Strong	Stretching	Afolhatic ester			
		Chrono	C-O	Allerd and other			
		Strong	stretching	Alkyl aryl ether			
2000-1650 cm ⁻¹	1705.07	Weak	C-H bending	Aromatic compound			
1670-1600 cm ⁻¹	1604.77	3.6.1	C=C	Conjugated allega			
10/0-1000 CM 1	1004.77	Medium	stretching	Conjugated alkane			
		Medium	N-H bending	Amine			





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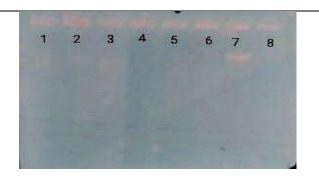
		Medium	C=C stretching	Cyclic alkene
1600-1300 cm ⁻¹	1512.19	Strong	N-O stretching	Nitro compound
	1450.47	Medium	C-H bending	Alkane
1400-1000 cm ⁻¹	1257.59	Strong	C-O stretching	Aromatic ester
		Strong	C-O stretching	Alkyl aryl ether
1400-1000 cm ⁻¹	1219.01	Medium	C-N stretching	Amine

Table 5:Cytotoxicity effect of lipids and miRNA against MCF7 breast cancer cell lines

Concentration of sample (µg/ml)	Percentage of cell viability (%)	IC 50 Value
Control	0	
5	73	
10	62	
15	57	
20	52	43.4045
25	46	

Table 6:Cytotoxicity effect of miRNA against MCF7 breast cancer cell lines

Concentration of sample (µg/ml)	Percentage of cell viability	IC 50 Value
Control	0	
5	66	
10	53	
15	49	
20	42	47.8980
25	31	



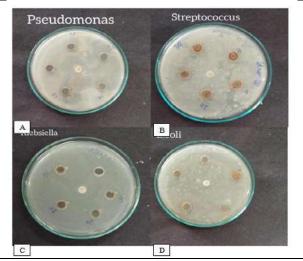


Figure 1: Analysis of miRNA using agarose gel electrophoresis.

Figure 2: Antimicrobial susceptibility of total phytolipids- kirbybauer disc diffusion method





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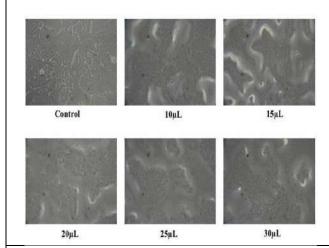


Figure 3: Anticancer activity of Lipid and miRNA of Alpinia calcarata was checked on MCF 7 cell line A control, B- 10µl, C- 15µl, D- 20µl, E- 25µl, F-30µl).

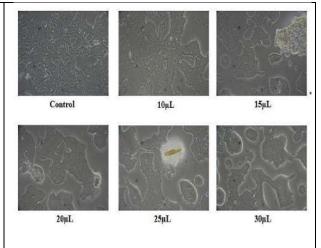
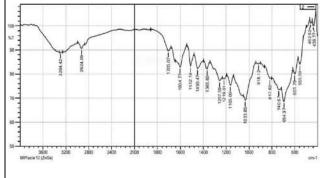
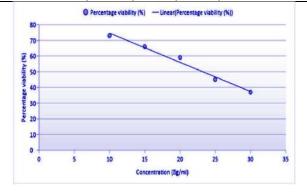


Figure 4: Anticancer activity of miRNA of *Alpinia* calcarata on MCF 7 cell line – A - control, B- 10 μl, C- 15μl, D- 20μl, E- 25μl, F-30 μl)



Graph 1: FTIR Spectrum analysis
FTIR analysis identified compounds based on their
functional groups. The peaks were from 550 to 4000 cm⁻¹
peaking at 3294.42 cm⁻¹, 2924.09 cm⁻¹, 1705.07 cm⁻¹, 1504.77
cm⁻¹,1512.19 cm⁻¹,1450.47 cm⁻¹,1365.60 cm⁻¹

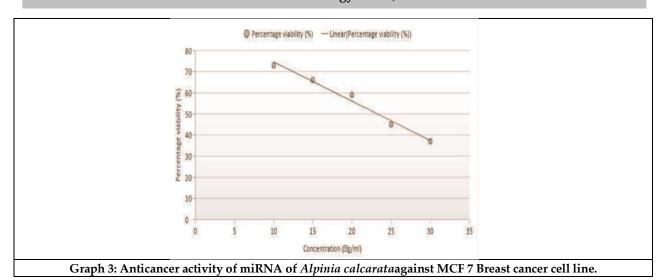


Graph 2:Anticancer activity of lipid and miRNA of *Alpinia calcarata* against MCF 7 Breast cancer cell





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REVIEW ARTICLE

A Review: Modeling Wildfire Risk using GIS Technology

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ABSTRACT

Wildfires are critical environmental disasters affecting biodiversity and climate change. Assessing their effects on ecosystems is crucial. Geospatial techniques help identify and map fire risks, reducing environmental damage. Wildfire risk simulation covers ignition, extinguishment, and protection causes, making it relevant in various stages of wildfires. The Geographical Information System (GIS) offers a mechanism to link spatial and description data that unites different variables that cause wildfireswith remote sensing data for determining and mapping wildfire dangers. All countries need to consider annual wildfire risks. In this paper, the Topographic Danger Index (TDI), Fuel Danger Index (FDI), Activity Danger Index (ADI), and Combustibility Index (CI) were discussed as factors of fire ignition and spreading where slope, aspect, and elevation affect the fire behaviour and spreading, while vegetation moisture, forest density, and vegetation type determine (FDI). On the other hand, distance from roads and settlements were studied as factors that affect (ADI). Besides, (CI) is associated with vegetation type and control fire behaviour. These indicators have been prepared by imputing weight values to each class of the layers related to the degree of their influence on fire behaviour and propagation using the GIS tool.

Keywords: GIS, moisture content, vegetation, behavior, value.





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INTRODUCTION

Around the world, wildfires occur and have varying effects on different regions. Massive, unmanaged flames have become more common in recent decades, and it is anticipated that these devastating, severe events will occur more frequently[1]. This eventually removes the qualities of the soil for generations to come and alters the vegetation's makeup. Forest fires also alter the hydrology cycles. Overall, the chaos caused by fires that destroy all types of flora makes the environment our top worry [2]. The incidence of forest fires is rising worldwide, with Asia seeing the highest number of these events. Human actions such as cigarettes and fireplaces, along with natural factors like extreme temperatures, lightning, or direct sunlight, can all start a fire [2][3][4]. Sensitivity represents a region's propensity to be harmed by wildfire, whereas risky factors characterize the likelihood of a fire occurring. The phrases "fire danger" and "fire risk" are sometimes used synonymously. The components of fire danger are those elements that affect how quickly a fire starts and spreads. Both natural (mainly thunderstorm-related) and human action may allow a fire to start [5]. The parameters that encourage forest firesinclude height, slope, separation from roads, and lands use/cover [6]. In the aftermath of the destructive fire periods that ravaged Mediterranean Europe (Portugal, 2003, 2005; Italy and Greece, 2007, 2009) and other nations (USA, 2000; Canada, 2003, 2004; Australia, 2006, 2007), there has been an increased need in the past few years for simulations and instruments that facilitate wildfire grew observing and forecasting. The application of fire modelling in wildfire management, landscape design, risk evaluation, and prevention offer a methodology for characterizing and forecasting the behavior and propagation of fires in a variety of challenging fire situations [7]. Forest fires are identified using satellite data and GIS methods; for increased precision, the MODIS satellite uses the middle and thermal infrared bands. Using vegetation maps or forest fuel models, fire-risk maps are created for early detection. To lessen the impact of forest fires on neighboring areas, precise risk zone mapping is essential [8]. Remote sensing aids in fire ecology studies by considering physiological yardsticks of the land environment, aiding in fire risk modelling, fuel visualization, active fire spotting, burned area estimations, and vegetation regrowth monitoring [9]. A dearth of research has been done on the temporal and spatial distribution of the scorched areas, even though numerous studies have been conducted utilizing satellite photos to determine and measure the burned areas. Considering remote sensing may recognize changes in fuel and soil moisture levels, amount of chlorophyll, vegetation loss, and other factors through variations in albedo values, it is an efficient tool for detecting and mapping regions affected by forest fires [10].

A fire risk sector is determined by shared environmental features that correspond to a common level of risk and determined by the reason for combustion and the shape of their incidence. The subdivision is completed by overlaying multiple maps that designate the areas based on risk rating as an indicator of the balanced sum of minor risks of each parameter that was earlier analyzed [11]. It is necessary to comprehend the elements that influence fire behavior and make an area fire-prone. Environmental analysis and fire detection are aided by GIS-based modeling and satellite remote sensing. By assisting in the prevention, reduction, or control of fire risk, these maps help forest managers respond appropriately in the event of a fire [12]. To manage the purpose of managing forest fires, including controlled burning strategy, fuel hazard evaluation, and wildfire control techniques, fire behavior data and modeling tools are essential. Unfortunately, the lack of training, data, and system trust limits their real-time applicability. A multifaceted phenomenon, fire affects different layers of plants and starts different kinds of flames depending on its growth parameters and characteristics [13]. Effectively addressing the many stages of wildfires prevention, suppression, and recovery—wildfire risk simulation is a fundamental method for revealing the intricate connections among fire occurrence, its causative agents, and its possible consequences. The processes for assessing and mapping risk have changed over time. Today, the majority of methods to map forest fire risk represent a wide theoretical structure that consists of multiple discrete but connected elements that can be examined independently and integrated into different stages of decision-making, such as property security and evacuating or the management of landscapes [1]. This review illustrates indicators of forest fire ignition and propagation that are used by ArcGIS for analyzing fire factors.





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MATERIALS AND METHODS

The data were gathered from research articles and web-based resources because the study is predicated on secondary data. Previous research has used case studies, data analysis, and modelling methods to estimate the intensity of wildfires, forecast their occurrence, and lessen the detrimental consequences of fires on the environment and people. Researching the causes of wildfires aids in assessing the intensity and behavior of the flames as well as our attempts to take preventative measures to save and safeguard both ourselves and the environment. The precise computation of fire propagation and condition quantities by the fire spread simulation facilitates the dynamic depiction of catastrophic data in the fire field. Forecasting the patterns of forest fire propagation, determining the original ignition areas from fire field photos, and assisting fire agencies in creating separation zones are some of its primary duties. The wildfire propagation speed model, collecting data, and fire spreading prediction methods are needed for the simulation, Figure 1[14][15].

RESULTS AND DISCUSSION

Hazard and Risk Modeling for Forest Fires Using Geographic Information Systems (GIS)

The most recent developments in forest fire modeling have given rise to several innovative implementation strategies for risk, threat, and vulnerability evaluation structures, which enable firefighters and administrators to assess forest fire risk models with more efficiency. These days, software programs can map the features of large-scale forest fires and simulate spatially precise wildfires over various of forestry fuel types[16], Figure 2.

Topographic Danger Index (TDI)

Considering topography variables have an impact on the existence of forests after wildfires, ArcGIS can be used to obtain slope, aspect, and elevation under topographical variability by applying Aster DEM [8].

Since slope affects fire behaviour and elevation and aspect have an impact on the mix of vegetation and moisture, TDI was calculated utilizing these variables [17].

TDI = Slope + Aspect + Elevation

.... Eq. (1)

Topography is a significant physiographic component that influences the region's susceptibility to fires because it is linked to the <u>behavior</u> of the wind. The fastest fire spreads upwards slopes and the slowest downward [18].

Slope

More quickly and intensely than they travel slope downward, and wildfires move uphill. With flames directed closer to the surface and wind enhancing the method of heat convection for the fire created, slopes that are steeper may see a faster rate of fire propagation[6].

Elevation

One important topographical feature that contributes significantly to the quick spread of wildfires is elevation. It is an important physiographic characteristic that is influenced by wind, humidity, and temperature. It also has an impact on atmospheric humidity, water in fuel content, and the structure of vegetation [19]. Forest fires are greatly influenced by this region's elevation or relief features, particularly when it comes to lightning-caused flames. Naturally occurring forest fires are primarily caused by lightning. Higher above, warmer air due to adiabatic motion increases the rate at which organic debris desiccates, potentially serving as fuel for a fire that gets out of control [6].

Aspect

In the North Hemisphere, southern aspects experience greater sunshine and exposure; as a result, dryersoil can catch fire more easily. Due to the increased solar radiation received by Southern sides, these slopes have greater temperatures, stronger winds, less fuel moisture content, and minimal humidity. The east aspect dries up more quickly than the west aspect in the early days because it receives a greater amount of sunlight and UV rays [18].





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Fuel Danger Index (FDI)

Remote sensing (RS), where sensors continuously capture multi-spectral data over an extended duration, is mostly used to study the temporal and spatial variation of vegetation over broad intervals and locations across complex settings and environments. Globally, vegetation patterns are often observed and investigated through the use of wavelength indicators [9][20]. Accordingly, on vegetation type, density, and moisture content, the fuel danger index is calculated [17].

Vegetation Type

The only feature of the environment that affects fire behavior is land use, which is impacted by the amount of fuel and the composition of vegetation. Fire vulnerability has an impact on the geographic distribution of ignition and the propagation of wildfires, which originate from a local core and spread across nature [21]. Earlier studies have examined the relationship between land use and burned areas, concentrating on how selectively fire spreads across different types of vegetative cover at local or national levels [22][21]. It was discovered that since bushes and conifers were more likely to burn, agricultural land, grasslands, and broad-leaved woods in Mediterranean regions were less damaged by fire[22]. When it comes to plants that grow naturally, Portugal is known for its drought-resistant, evergreen species. In recent years, socioeconomic and demographic alterations in rural areas have also resulted in the reforestation of old agricultural fields and the disappearance of agricultural land, which has allowed shrublands to expand. There is a greater risk of fire in both situations due to the increased fuel storage[23].

Normalized Difference Vegetation Index (NDVI)

When identifying vegetation-bearing regions on a remote sensing image, there are many indicators available. An index that is frequently and extensively used is the NDVI[24][25]. This significant vegetation index is frequently used in studies on the effects of climate change as well as other worldwide environmental issues. The ratio variation between the recorded forest reflection in the red and near-infrared bands, accordingly, is used to compute the NDVI [25]. So, Using the NDVI, which measures flora greenness, one may determine the concentration of vegetation and track changes in the general state of health of the plants. NDVI Index, which is the most frequently employed in research, is a wavelength measurement that is derived from the difference between the red (situated near 0.66µm) and near-infrared (situated near 0.87µm) radiation over their combined value. It has been used extensively in tracking vegetation and identifying problems with forests and is correlated with plant matter and environmental conclusions [20], Table 1. The NDVI score varied from -1 to +1; a greater value denotes extensive growth and a lesser value, a lack of growth. Dense areas of vegetation have a higher risk of wildfire[26][27][28][29]. As the NDVI is susceptible to changes in atmospheric conditions and a narrower spectrum of spectrum reflection from plants [27], the NDVI can represent changes in the geographic distribution and features of local vegetation, it can also be a useful tool for researchers and those involved in land development and ecological preservation. In this instance [30].

Normalized Difference Moisture Index (NDMI)

An analytic tool for estimating soil moisture and analyzing its temporally fluctuations is the Normalized Moisture Difference Index (NDMI). Due to its ability to calculate the amount of moisture in the soil for geographical characteristics such as rocks, vegetation, and soil, it is utilized in conjunction with NDVI and LST metrics to evaluate dryness[31]. The Normalized Difference Moisture Index (NDMI) indices are utilized to produce information on the amount of moisture in the plants. The values fall between -1 and +1. Here, +1 denotes extremely high moisture level on plants, whereas -1 denotes extremely low moisture content[28]. NDMI is a more pertinent and reactive vegetation index than standard ones based on NIR-RED. It can be effectively implemented for satellite platforms with suitable wavelengths and can identify the water capacity in various layers of green vegetation. More intricate and subtle vegetation photos are available with NDMI[32].

The terms Near Infra-Red (NIR), Short-Wave Infra-Red (SWIR), and RED (R) that are given in the equations.

Activity Danger Index (ADI)





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It is important to emphasize the intricate interaction between natural and man-made flames. Humans affect the fire cycle both directly and indirectly by changing vegetation, starting and extinguishing fires, and dividing ecosystems[35]. The proximity of road and populated regions can be a helpful indicator of high-risk zones for human

Human Settlement

With the increase in human expansion, the demand for forest border areas has increased in the past few decades. Forests provide means of living for tribal residents. People who live near forests occasionally start small fires to collect wood for heating, clear paths through the forest, conceal illegal timber harvesting, scare of predators, carry out traditional practices and rituals, etc. Frequently, these small fires turn into unmanageable forest fires that pose a serious risk of fire [8]. Additionally, because people living inside forests may unintentionally start fires, woodland and grassland areas close to populations are more likely to experience flames [36].

Road Density

Key elements in averting fires in forested areas are road density and closeness. Maintaining a secure distance from road schematics is crucial since they have a direct effect on firefighters' capacity to manage large fires and increase the danger of fires caused by humans [19]. An increased risk of fire is associated with increased human activity. Roads encourage people to enter meadows and woodland regions, which might lead to fires, hence the proximity to and density of roads are possibly significant factors[36]. Since human populations have constructed tiny roads inside the periphery of woodlands, these roads pose risk as they are closer to the forest and the risk of fire occurrence will be bigger. Traffic volume on forest roads can be contributed to the likelihood of forest fire. Untended campfires by travellers, the discarding of burning fuel from roadside cooking, and the tossing of spent cigarette butts are all common causes of accidental[8].

Combustibility Index (CI)

First of all, it is important to mention that leaves, grass, and trees are combustible elements that can serve as excellent fuels to start fires. In regions with dense, dry vegetation, wildfires are more prone to take place. The reason for this is that fuel that is closest to the flames might spread quickly [26]. Many parameters influence fire behavior such as wind, normalized difference moisture index (NDMI), slope, and aspect. As it is noticeable that all factors have discussed in details in advance, another factor contributes to the determination of fire behavior which is the Combustibility Index. Fire severity is related to vegetation characteristics and that defines the Combustibility Index (CI) [37], this index allows the identification of all fuel types and their roles and effects on fire behavior. For this reason, an analysis of the research areas' vegetation covering is required [37]. It is necessary to distinguish between fuel types and their ability to ignition depending on the Land-use map of any area [37].

CONCLUSION

By identifying fire behavior characteristics, fire ignition and spread factors, and fire risk index, the importance of the current paper is to mention that Geographic Information System technology (GIS) and remote sensing (RS) are working together to establish the fire hazard index. Wildfire parameters simulation is so crucial to predict fires and take precautions to protect our forests and conserve the environment. In this paper, we explained the main factors that may affect fire behavior and spread, such as fuel index (FDI), topography index (TDI), road density, population (ADI), and combustibility index (CI) that can be analyzed using GISbesides their role in helping all departments concerned with forest conservation.

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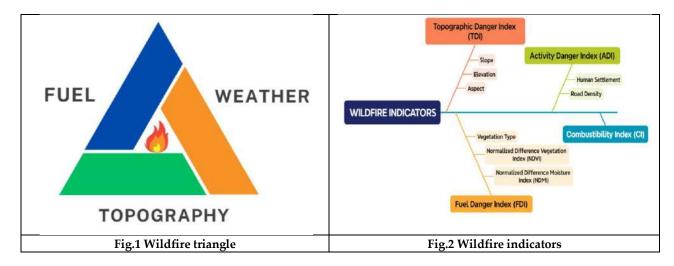




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Table 1. Fuel Danger Index (FDI) Calculation Using Obtained Wavelength Indicators from the Reflection of Land Surface

Vegetation Metrics	Equations	Landsat 5 - 7	Landsat 8	References
Normalized Difference Vegetation Index (NDVI)	$NDVI = \frac{NIR - R}{NIR + R}$	$NDVI = \frac{\text{band 4 (NIR)} - \text{band 3 (RED)}}{\text{band 4 (NIR)} + \text{band 3 (RED)}}$	$NDVI = \frac{\text{band 5 (NIR)} - \text{band 4 (RED)}}{\text{band 5 (NIR)} + \text{band 4 (RED)}}$	[28][30] [29][33]
Normalized Difference Moisture Index (NDMI)	NDMI= NIR-SWIR NIR+SWIR	$ NDMI = \underline{\text{band 4 (NIR)} - \text{band 5 (SWIR)}} \underline{\text{band 4 (NIR)} + \text{band 5 (SWIR)}} $	$ NDMI = \underline{\text{band } 5(\text{NIR}) - \text{band } 6(\text{SWIR})} \underline{\text{band } 5(\text{NIR}) + \text{band } 6(\text{SWIR})} $	[28][34] [33]







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RESEARCH ARTICLE

Using a Pi-Fuzzy Controller and a Three-Phase Three-Level AC/DC Converter, Electric Vehicle to Power Grid Integration

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ABSTRACT

This paper presents the control and simulation of an electric vehicle (EV) charging station using a threelevel converter on the grid-side as well as on the EV-side. The charging station control schemes with three-level AC/DC power conversion and a bidirectional DC/DC charging regulator are described. The integration of EVs to the power grid provides an improvement of the grid reliability and stability. EVs are considered an asset to the smart grid to optimize effective performance economically and environmentally under various operation conditions, and more significantly to sustain the resiliency of the grid in the case of emergency conditions and disturbance events. The three-level grid side converter (GSC) can participate in the reactive power support or grid voltage control at the grid interfacing point or the common coupling point (PCC). A fuzzy logic proportional integral (FL-PI) controller is proposed to control the GSC converter. The controllers used are verified and tested by simulation to evaluate their performance using MATLAB/SIMULINK. The comparison of a PI-controller and a PI-Fuzzy controller for the EV charging station shows the effectiveness of the proposed FL-PI controller over conventional





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PI controller for same circuit operating conditions. A good performance for PI-Fuzzy in terms of settling time and peak overshoot can observed from the simulation results.

Keywords: EV charging station; three-phase three-level; AC/DC converter; FLC control

INTRODUCTION

Overview of Wireless Power Transfer (WPT)

Since Nikola Tesla invented the method of wireless power transmission, the innovation of wireless power transfer has attracted a lot of attention. Because magnetic resonance wireless transmission is effective and has a significant charging range, it is recommended[1]. It is extensively utilized in many contemporary and daily applications, such as wireless mobile phone charging, electric car charging, biomedical implants, etc. A study from 1980 that describes how wireless power transfer powers electric trains operating in a Soviet Union mine is one of the earliest examples of attempts to use wireless power innovation for large amounts of electricity. Most likely, the risk of fire in the mine led to the use of the wireless power transmission technology. Most likely, the risk of fire in the mine led to the use of the wireless power transmission technology[1], [2]. Then, the results indicate that the power transmission frequency was 5 kHz, indicating that the productivity was probably not very high. There was only a few millimeters between the two points of power transmission. Large currents could be controlled at relatively high frequencies of 20 kHz or more in the 1990s, which led to a rapid advancement in wireless power transfer technology. Its use is demonstrated by the autonomous carriages that operate in semiconductor manufacturing facilities where dust is prohibited. This led to a 90% power transfer efficiency, and this type of WPT system is now the norm. Still, not much is done to improve the transmission distance; the coil's size is a determining factor [3], [4].

Joint Improvement of Wireless Charging Systems

IHI and WiTricity Corporation (U.S.) have collaborated to enhance deeply coupled magnetic resonance charging invention, which has enabled very effective power transfer over many centimeters. This invention was the result of research done in 2007 by MIT researchers who were able to light a 60W bulb at a distance of two meters (Lu, 2015). This conclusion disproved the information that was available at the time about WPT innovation in terms of transmission distance, which contributed to its rise in popularity in 2007[5]. The corporation began working together to boost remote charging frameworks after assuming management of the innovation from MIT. Since there had been essentially little change at the research facility level, the focus of development has been on how to best leverage this innovation. With our focus on EV and PHEV charging, we work hard to provide a framework that is easy to use. The comfort and ease of consumers are the top priorities in this progress.

Wireless Power Transmission System for Electric Vehicle Charging

The three most important things to consider in WPT systems when lowering the reluctance effect concerning the efficiency of the power transferred for great air gaps are shape, dimensions of coils, choosing coil and core materials. The charging operation for wireless electric vehicles is as depicted in Figure 1. Here, the inverter converts the AC power from the grid to a DC power needed by the converter and again rectified to AC suitable for the transmitting coil placed on the ground. The transmission of this AC power took place wirelessly by magnetic resonance method to the receiving coil placed under the vehicle's chassis and converted back to DC power used to charge the battery[6].

Features of WPT Structure for Charging Electric Vehicles

There are three essential requirements an effective and suitable electric vehicle charging structure has to meet: large air gap, high power and high efficiency (Beh, 2010). Electromagnetic waves serve as a means of propagating energy in an RF & Microwave system (Sample, 2011). This transfer of power takes place over air gaps within some km;





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however, it results in some drawbacks such as line of sight transmission, low power (less than 1 kW) transmission, a great loss in the air, low efficiency and an extensive effect on its environment (Wang, 2011). Inductive Power Transfer (IPT) (Xui, 2013) also referred to as non-resonant inductive method (Karalis, 2008) or electromagnetic induction or inductive coupling method (Sample, 2011) has low charging distance (about few centimeters) (Xui, 2013) because of its loose coupling between the receiving and transmitting coils respectively (Hasanzadeh, 2012). The MIT research team proposed the magnetic coupling resonant technique (Kurs, 2007), also referred to as resonant inductive power transfer (Musavi, 2012) in 2007 which has been demonstrated alluring for EV and PHEV charging applications due to its mid-range charging distance efficiency (100-300mm), low loss in its surrounding, low interference and its omnidirectional characteristics (Cheon, 2011). From the figure 1-3 and table 5, it is also noticeable that the amount of mutual inductance between the transmitting coil and the receiving coil slightly changes since each is the sum of its own self-inductance and the mutual inductance of the other coil. As the other coil gets closer due to the direction of the excitation current defined, the value slightly fluctuates because there is still some flux present. The design of the system circuit is created in ANSYS Simplorer while the design of the transmitting and the receiving coils is created in ANSYS Maxwell. This Maxwell design held the dynamic inductance information about the coil structure and imported the Simplorer as L parameters. At the transmitting side, the resonance capacitor is connected in series with the inductor to have maximum current flowing through the inductor, hence, maximum power is delivered to the transmitter. At the receiving side, the capacitor was connected in parallel with the inductor to have a maximum voltage drop on the load resistor.

An AC analysis needs to be set up to determine the efficiency of the system. Below I have shown the parameters for the analysis. From figure 1-6, the system's efficiency reaches its peak of about 98.3% at a resonance frequency of 0.35 MHz. At any frequency apart from the resonance frequency, the efficiency reduces. This indicates that the magnetic resonance method is a very efficient way of transferring power wirelessly over a mid-range distance. In addition, the 3D rectangular plot helps to verify the efficiency of the system with respect to the spacing between the coils and its operating frequency produced at 98.3%. The transient analysis is set up to determine the frequency analysis of the system. Below are the values for the setup. Figure 4-17 shows the complete system of a magnetic resonance WPT circuit designed in Maxwell. The circuit consists of a power supply source, rectifier, inverter, transmitting coil, receiving coil, and a load. The power supply, which is an AC source, needs to pass through the rectifier and then be converted back to AC by an inverter because the coils need an AC voltage to operate. The reason why the AC supply passes through the rectifier first is that, the AC voltage from the grid is not suitable for the transmitting and receiving coils.

Comparing with Magnetic Induction Power Transfer

In magnetic induction wireless power transfer, the current passes through the transmitting coil, which produces a varying magnetic field. This induces a current in the receiving coil which helps to charge the electric vehicle. Its power transfer efficiency depends on the closeness of the two coils. Using the same coil design and parameters and keeping the same distance between both coils as in the magnetic resonance method, results show that the efficiency of the inductive coupling method reaches its peak at 60.145%. This confirms that wireless power efficiency is low in the inductive coupling method over large distances.

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CONCLUSION

This research delved into the effectiveness of the wireless-based resonance charging system through simulation results. The simulation results obtained from ANSYS Maxwell verify the effectiveness of the electromagnetic resonance technique. The energy transfer efficiency depends on the operating frequency. Results show that the energy transfer efficiency of a resonance-based wireless energy transfer system reaches the maximum (98.3%) at the resonant frequency. If the system is set at a frequency other than the resonance frequency, there is an abrupt drop in the energy transfer efficiency. Additionally, the design of a magnetic induction verifies the effectiveness of wireless power transfer with magnetic resonance over large distances as simulation results show that the efficiency of power transfer with the induction method over large distances is about 60%. Therefore, the magnetic resonance wireless charging is a more efficient method for charging the electric vehicle.

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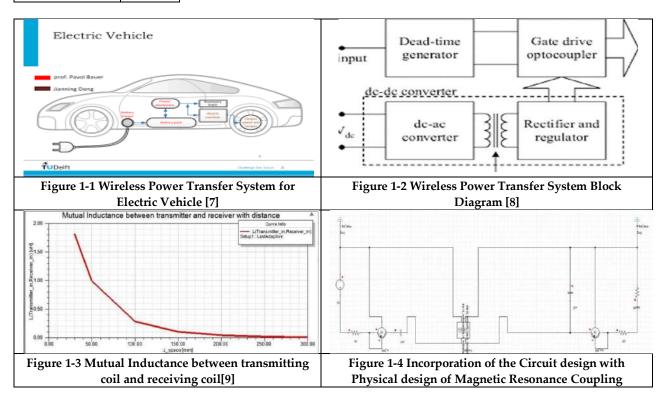


Table 1. Parameter values

Parameters	Value
Voltage	280V
Frequency	6.5KHz
R _i	9.δμΩ
R_2	9.8μΩ
C_{rx}	20µF
C_{tr}	20μΓ
R _{Load}	50Ω

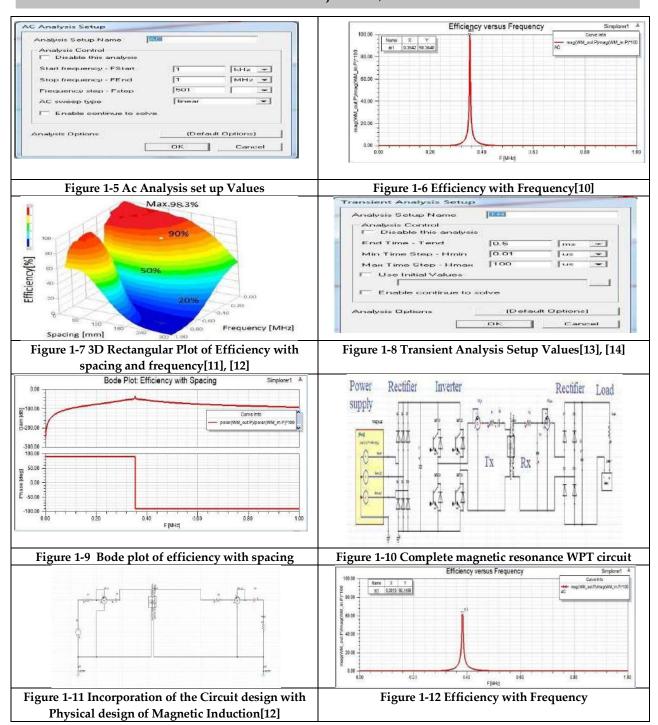
Table 2: parameters and values

Parameters	Value
3 phase Voltage	280V
Frequency	10KHz
C1	900μF
C2	7μF
R1	$7.1 \mathrm{m}\Omega$
R2	$4 \mathrm{m} \Omega$
Ctx	1.6µF
Crx	4.7μF
RLoad	50Ω



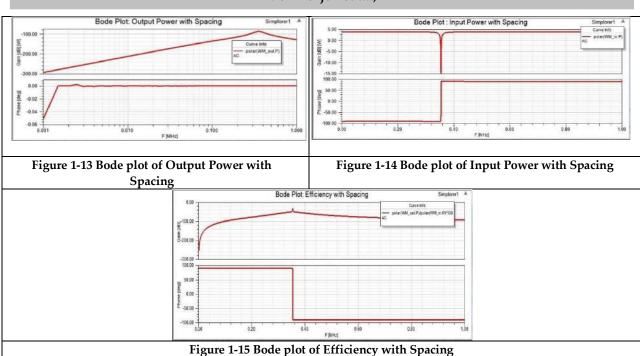
















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RESEARCH ARTICLE

Detection of Diabetes Mellitius using Soft Voting Ensemble Machine Learning Algorithm

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ABSTRACT

Diabetes mellitus is a chronic condition characterized by abnormal and persistent high levels of glucose in the blood that cannot be cured. Currently, the healthcare industry possesses a substantial database. Machine learning and deep learning are disciplines that analyze vast datasets to extract significant insights for the early detection of diseases. This study report utilizes the Pima Indian diabetes dataset, which contains information on diabetic and non-diabetic patients like Glucose levels, Age, Blood pressure, etc. We utilized a soft voting ensemble machine learning model in our research, where each base model contributed to the weighted average of probabilities to determine the final prediction of a patient's diabetes status. The model ensemble comprises eight machine learning algorithms: Naive Bayes, Logistic Regression, K-Nearest Neighbors (KNN), Decision Tree, Random Forest, Support Vector Machine (SVM), XGBoost, and LightGBM, used for classification. The experimental findings indicate that the ensemble model achieved a peak accuracy of 90.13%. Our algorithm assists medical practitioners in timely patient prediction and diagnosis.

Keywords: Diabetes; Accuracy; Diagnosis; Ensemble, Predicition; Machine Learning





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INTRODUCTION

In the modern world, diabetes mellitus is a common metabolic disorder that cuts off human life at an early age. Diabetes mellitus is generally known as diabetes [1]. The blood glucose in the human body is the rich source of energy and which is generated from carbohydrate foods [2]. Insulin regulates the sugar level in the blood to prevent high and low sugar levels problem [3]. Diabetes mellitus, which causes the organ pancreases to be unable to produce enough insulin, due to a deficiency of insulin level in the human body, does not maintain blood glucose levels and causes many serious complications in the body such as stroke, kidney failure, eye blindness, nerve damage, etc [4]. Diabetes mellitus is divided into three parts. Type-1 diabetes allowed the body to destroy beta cells that live in pancreases and stop generation of insulin. Generally, it is related to genes and is mostly found in children [5]. Type 2 diabetes occurs more commonly found in 18 to 70 year-olds. In this type-2 diabetes, the human body organ pancreas produces an inadequate amount of insulin or resists the genration of insulin, which makes it unable to maintain blood glucose levels [6]. Type 3 diabetes is known as gestational diabetes; it developed during the pregnancy period of the woman and finally affects the generation of the baby after the birth and causing death [7]. As of now, current research in medical science does not provide full care for diabetes; only early complication growth symptoms identification and prediction of diabetes mellitus can control the spreading of the disease [8]. The development of intelligent systems in the medical field gives valuable information to the medical practitioner for the diagnosis of disease [9]. Machine learning and data mining technique have great strength in managing bulk amounts of dataset originated from several sources for auspicious examination and information extraction. This research work focused on building an ensemble model using a soft voting classifier for classifying diabetic and non-diabetic patient in given dataset. Nave Bayse, Decision Tree, Random Forest, Logistic Regression, Support Vector Machine, XGBoost, and LGBM all machine learning model output have been combined and found the performance of the ensemble model achieved a better result as compared to the given base model classifier. The best parts of this research paper are prepared as follows: Section II presents the literature review on machine learning model and ensemble methods used in this area. Section III gives the methodology for the ensemble approach, which uses soft voting for the classification of diabetes. Section IV gives the experimental findings using the suggested model. Section V presents the conclusion of the research work.

RELATED WORK

In last one decade many excellent research has been done for the classification of diabetes using machine learning models. HafsaBinteKibria et al. (2022) developed an ensemble machine learning model for the classification of binary class diabetes dataset intodiabetic and non-diabetic patient. Algorithm ensemble of Artificial Neural networks (ANN), Random forests, Support Vector machines, Logistic regression, and XGBoost. In this paper, Pima India diabetes dataset was used for the experimental work. The missing value was imputed using the median value technique and to balance the dataset a technique of synthetic minority oversampling were used. This model used five-fold cross-validation to get a maximum accuracy of 90%[10]. RamyaAkula et al. (2019) discussed the prediction of Type-2 diabetes using an ensemble model. The model used Pima India diabetes dataset for the experimental work. The performance matrix was used to measure the robustness and accuracy of the model. Result obtained by the ensemble model with 89.1% accuracy[11]. GauravTripathi et al. (2020) give a comparative study of four machine learning model for the early prediction of diabetes mellitus. In this model, Pima India diabetes dataset was used for the experimental work and performance was computed by comparing all machine learning model, such as Linear Discriminant Analysis, K-Nearest neighbour, Support Vector machine, and Random Forest. Found that random forest outperformed the other four algorithms with 87.66% accuracy[12]. UmairMuneer Butt et al. (2021) presented a machine learning model for the prediction and classification of diabetes and also used an IoT-based hypothetical monitoring system for monitoring the person's blood glucose level. In this experiment, the Pima India diabetes dataset is used. Experimental results found that LSTM gave the highest prediction with 87.26% accuracy[13]. SaloniKumari et al. (2021) discussed the classification and prediction of diabetes patient using an ensemble model. They utilized the Pima India diabetes dataset and the breast cancer dataset for the experiment. In this model, the





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Pima India diabetes dataset is normalized using linear transformation of data and missing or null values are replaced by the mode of the individual column features. The accuracy of the ensemble classification using soft voting is 79.04%[14]. YashiSrivastava et al. (2019) estimated gestational diabetes using a machine learning model. For the experiment, we used the Microsoft Azure AI service performed on the Pima India diabetes dataset. To compute the performance of the algorithm, divide the dataset randomly in the ratio of 70% and 30%, where 70% of the dataset sample was used for the training purpose and 30% dataset sample for the testing purpose. Two-class logistic regression is used to predict diabetes with an accuracy of 77.8%[15].

The research objectives are summarized as follows:

- The proposed model classifies the diabetes mellitus into diabetic and non-diabetic classes using Pima India diabetes dataset
- To test the suggested model's robustness,F1-score Accuracy, Recall and Precision were used as the evaluation criteria.
- A comparison of the existing base machine learning model with the proposed ensemble model for finding the superior result

PROPOSED METHODOLOGY

In this research paper extensive focus on enhance the accuracy of the proposed model for the early and accurate detection of diabetes. Researchers have developed an ensemble of machine learning model for the classification of diabetes dataset using soft voting classifier. The figure1shows the flow chart of the suggested ensemble model using a soft voting classifier.

Dataset

In this experiment, the Pima India diabetes dataset was used and patient data has collected by the University of California Irvine for the research work. The diabetes dataset was downloaded from the given website www.kaggle.com/datasets/uciml/pima-indians-diabetes-database. The dataset has eight valuable feature columns and one output column that specifies whether the person has non-diabetic (0) or diabetic (1). The given dataset has 768 records, of which 268 are positive diabetes and the other 500 are negative diabetes.

Data Pre-Processing

Data pre-processing is utmost important step in machine learning model because model output was completely depend on the more valuable and efficient format of data. The first step in data pre-processing is addressing missing values in the feature column, and all the missing or null values are replaced by the mean of the particular feature column. In second step, data pre-processing is data normalization and in this min-max operation to perform linear transformations of the data to convert all eight independent feature column values into the same range between 0 and 1.

Data Split

In this step, the researcher randomly divided the dataset into two parts, 80% and 20%. The 80% part is used to train the model and the 20% part of the dataset is used to test the performance of the model.

BASE MODEL

Naive Bayse

The working principle of Naïve Bayse algorithm depends on probabilistic method. It is a supervised machine learning algorithm used for solving classification problems. It uses the Bayes theorem by the consideration that the





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existence of one sample in a given class is independent of the existence of another sample in the same class. This independence consideration requires studying each parameter individually for every term.

Logistic Regression

It is more popular supervised machine learning classification algorithm. Logistic regression is almost identical to linear regression except that linear regression is used for the continuous data outcome and logistic regression is used for solving the classification outcome. It works on the probabilities of an event occurring, and sigmoid function is used to map each data point in the dataset.

KNN

It is a supervised algorithm used in machine learning for both regression and classification problems. In this algorithm, the new feature class is determined based on the distance or similarity measurement of existing features in the same class. Generally, the Euclidean distance or Manhattan distance is used for measuring the similarity of a new feature with an existing class feature. This algorithm is very slow because it does not straightaway learn from the training dataset; rather, it stores the training dataset and applies an action to it when classifying.

Decision Tree

A decision tree model is used in both classification and regression problems, but it is more popular in solving classification problems. This work uses the graphical representation of a dataset to get the optimistic solution to a decision based on the given condition. A decision tree consists of two nodes, which are the decision nodes and leaf nodes. Decision nodes are used for to make the decisions, and if possible, n- number of branches and leaf nodes shows output of the decision tree.

Random Forest

It is one type of ensemble machine learning classifier algorithm. It consists of many trees and bootstrap aggregation techniques and applied training dataset to every tree in the algorithm. Each decision tree gives a high variance output; when it is combined and each of them is taken in parallel, the resultant variance is low, and the resultant output does not depend on single decision tree output but on multiple decision trees output.

Support Vector Machine

Support vector machines are used for both regression output and classification output problems. In this we can quickly place the new data sample in the appropriate category of the feature by creating the best decision boundary that divides n-dimensional space into classes. SVM chooses the optimum hyperplane in the multi-dimensional space, and the correct hyperplane has the maximum distance between the two ends of the data point. The unknown feature sample point is classified based on the hyperplane and fit into either one of the classes along the hyperplane.

XgBoost

It is a supervised machine learning algorithm used in both regression and classification problems. It uses a gradient boosting algorithm and an ensemble approach to train the model. The accuracy achieves of this model is higher than a single decision tree but sacrifices the basic interpretability of a decision tree.

Light GBM

It is a supervised ensemble machine learning classification algorithm used in both regression and classification problems. It is an extension of the gradient boosting algorithm, automatic feature selection and focusing on boosting examples with large gradients. It utilizes two techniques: gradient-based one-side sampling and exclusive feature building, which result in improved speed of training and accuracy of performance.





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PROPOSED MODEL

The proposed model for binary classification (1 or 0) consists of merging the same or dissimilar machine learning classification model form a strong meta-classifier model that predicts through majority voting. Hard vote classifiers and soft vote classifiers are the two types of voting classification used in the ensemble classification technique: Hard vote classifiers and soft vote classifiers. In hard voting, input data is classified based on the mode prediction made by each base model, with the class that receives the most votes as the final prediction. In soft voting, classify input dataset on the probability score of each base model for each class and calculate the weighted average of the probability to make the final prediction. The presented ensemble soft voting classifier model achieves higher accuracy results than other base models classifier, as it merges the predictions of different models. This model ensemble Naive Bayse, Decision Tree, Random Forest, Logistic Regression, Support Vector Machine, XGBoost, and LGBM. Ensemble soft voting classifier has been used to measure the probability of each base model and average of this probability makes the final decision. The basic programming structure of the proposed model is written in Anaconda platform using Scikit-Learn library, as shown in the figure 2.

RESULT

The proposed model uses the Pima India diabetes dataset for the experiment. The dataset has 768 patient records and 9 feature columns, with 268 positive samples of diabetes and 500 negative samples of diabetes. Figure 3 shows the ratio of non-diabetics (0) and diabetic (1) patients in the dataset. The given dataset was split randomly into two parts. 80% of the dataset used in training the model and 20% of the dataset used in testing the model. The confusion matrix in figure 4 was used to determine the model's performance. The most important evaluation parameters, Accuracy (1), Precision (2), Recall (3), and F1-Score (4) are used to measure the algorithm's robustness and effectiveness. They are determined using the formula below [16].

$$Accuracy = \frac{Tp + Tn}{Tp + Tn + Fp + Fn}$$

$$Precision = \frac{Tp}{Tp + Fp}$$

$$Recall = \frac{Tp}{Tp + Fn}$$

$$(3)$$

$$Precision = \frac{Tp}{Tp + Fp} \tag{2}$$

$$Recall = \frac{Tp}{Tn + Fn} \tag{3}$$

$$F1 - Score = \frac{2*Precision *Recall}{Precision + Recall}$$
(4)

Where,

Tp is the true positive means the value of the predicted outcome is 1 and actual outcome is 1.

Tn is the rue negative means the value of predicted outcome is 0 and the actual outcome is also 0.

Fn is the false negative means the value of predicted outcome is 0 but the actual outcome is 1.

Fp is the false positive means the value of predicted outcome is 1 and the actual outcome is 0.

The comparative study of the proposed ensemble machine learning algorithm with the base machine learning algorithm for the diabetes mellitus classification as shown in performance shown in Figure 5. Table 1 shows that the performance of individual algorithm are less than the proposed ensemble model with accuracy 90.13% result and figure 6 shows the AUC curve with the auc value 93%.

CONCLUSION

Diabetes is a slow poison that is normally found in young generation these days and early prediction of this disease is always a challenging problem for practitioner. The aim of this research paper has to achieve high-accuracy performance model for predicting early and accurate diabetes disease. The researchers have proposed an ensemble model using a soft voting classifier. The PIDD dataset from UCI was used for the experiment work, and performance





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matrixes such as accuracy, precision, recall, and F1-scor have been evaluated. The ensemble model examined on the 768 sample and it was able to achieve an accuracy of 96.48%.

Conflict of Interest

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

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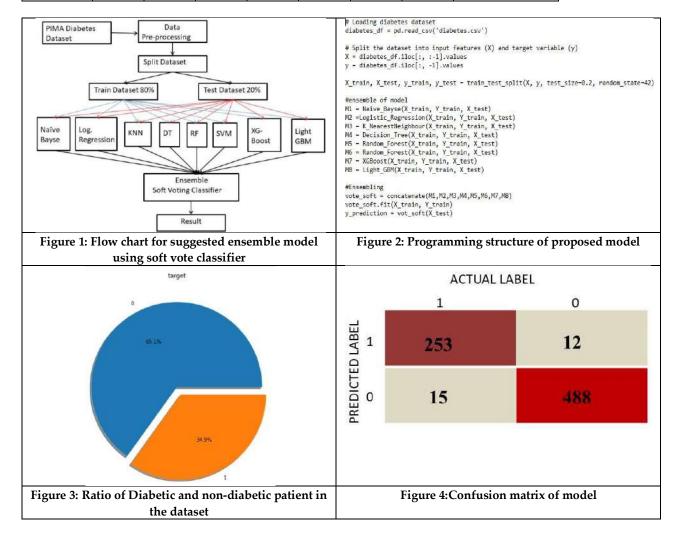




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Table 1. Comparisons of the machine learning algorithm

				0 0				
Parameter	NB	LR	KNN	DT	SVM	XGB	LGBM	Proposed Model
Accuracy	82.13%	84.86%	84.07%	80.12%	85.39%	89.07%	88.28%	90.13%
Sensitivity	72.16%	71.92%	70.18%	70.96%	74.16%	78.75%	76.36%	82.36%
Precision	70.12%	74.36%	69.32%	68.69%	81.38%	75.16%	73.12%	85.51%
F1-Score	71.12%	73.11%	71.66%	69.8%	77.6%	76.91%	74.7%	83.20%





AUC = 0.93

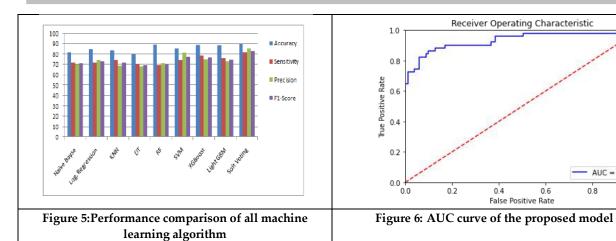
1.0

0.8



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RESEARCH ARTICLE

Unveiling Cognitive Shifts: A Comparative Analysis of Selective **Attention across Generations**

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ABSTRACT

This comprehensive review examines the intricate dynamics of motivation, stress, information processing, and attentional patterns across Generations X, Y, and Z. Generation X, motivated by practical outcomes and adaptability, contrasts with Millennials, seeking purpose and continuous learning, while Generation Z is propelled by technology and entrepreneurial aspirations. Stressors vary, from financial pressures affecting Millennials to academic stress impacting Generation Z and Generation X grappling with work-life balance and technological adaptation. The review explores the evolution of communication methods, perceptual loads, and the prevalence of ADHD across generations, anticipating further shifts influenced by immersive technologies and evolving social media platforms. As societal awareness of mental health grows, accommodating attentional differences becomes crucial, necessitating adaptive environments for optimal cognitive well-being. Educators, employers, and policymakers must navigate these dynamics to foster a balanced approach that embraces individual differences and promotes mindful engagement with information, ensuring the adaptive and enriching future of selective attention across diverse generations amidst technological advancements and cultural shifts.

Keywords: Selective attention, Generations, Motivation, Stress, Perceptual loads.





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INTRODUCTION

William James, an American philosopher and psychologist, defined attention as "the taking possession by the mind, in clear and vivid form, of one out of what may seem to be several simultaneously possible objects or trains of thought"(11.2: History of attention, 2020). According to a Canadian-American professor, "attention is the process of getting an object or thought clearly before the mind" (Cognitive Psychology_Draft 2, n.d.). Another psychologist, Morgan, stated, "Attention is being keenly aware of some specific factors in our environment. It is a preparatory adjustment for response" (Reshma, 2016). Specifically, attention is a cognitive process of selection of a particular stimulus that can either be an external stimulus from the environment or internal thoughts, by will or by instinct, to focus or concentrate by selecting or eliminating sensory information from different senses on a multimodal level. Attention is categorized into four groups: selective attention (attending to a specific stimulus while other stimuli are present), divided attention (attending to various stimuli simultaneously), sustained attention (long-term attention to a given stimulus), and executive attention (switching attention between different stimuli while organizing thoughts). Though we are all the same human at the molecular level, we have different temperaments and ways of persevering with the environmental changes around us. This perception can be influenced by an individual's learning and also by his surroundings. One such cognitive process that changes with time and growing age is the ability to maintain attention on a given task or any other distractive thought. This paper is going to look at the factors that make these changes among descending generations, analyse studies done by different people on selective attention in each of the generations, and compare their attentional differences. The generations under consideration are: generation X (born between 1965 and 1981), generation Y(born between 1982 and 2000), and generation Z (born between 2001 and 2014).

SELECTIVE ATTENTION

According to Broadbent's filter model, selective attention can be seen as a filter that helps to screen out irrelevant information or stimuli. This theory proposes that selective attention works by blocking all but one stimulus from entering awareness(Sullivan, 1976; Lachter et al., 2004; Treisman, 1969. Another theory of selective attention is Treisman's attenuation model, which states that selective attention temporarily reduces the strength or effectiveness of distracting stimuli instead of blocking them completely(Puri &Treasaden, 2009; Driver, 2001). The cognitive process of focusing on some features of the environment while disregarding others is referred to as selective attention. Due to the limited processing capacity of the human brain, selective attention helps us to prioritize and allocate resources to the most relevant stimuli. Selective attention is driven by visually focusing on the selected stimulus, concentrating on a particular sound or a conversation while filtering out other auditory stimuli, and focusing on the texture and shape of an object in contact. The nature of the stimulus that attracts selective attention is preferred to be novel or fulfil a need or a want. Often times, the stimulus that needs to be focused on is surrounded by distractions that are external, i.e., other stimuli in the environment, or internal, i.e., hunger, thirst, sexual desire, and thoughts. This cognitive process allows us to prioritize work, improve our productivity, and retain mental clarity. Understanding why selective attention is so crucial might help us increase our productivity and wellbeing(Isbell et al., 2017). When confronted with various options, our ability to selectively attend to critical factors aids in objective evaluation, considering potential consequences, and ultimately making well-informed choices. This filtering process not only prevents cognitive overload but also helps combat decision fatigue. Selective attention is also instrumental in shaping and retrieving memories. By concentrating on specific details, we can more efficiently encode information into our memory, facilitating the transfer from short-term to long-term memory. This focused attention on meaningful information not only aids in memory formation but also streamlines the retrieval process by filtering out extraneous details, thereby reducing cognitive load. Amidst the constant barrage of stimuli and information in today's world, selective attention plays a pivotal role in stress reduction(Karim, n.d.). By sieving out irrelevant information, it acts as a buffer against mental overwhelm, allowing for a clear mental state. Selective attention empowers individuals to direct their focus toward tasks requiring immediate attention, thereby minimizing stress induced by distractions and information overload.





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CONSIDERED GENERATIONS

In ancient eras, the term "generation" encompassed all individuals currently alive. However, its meaning has evolved over time, transitioning into more of a biological context that delineates the period from one's birth to when they become parents. As the average age of childbirth has increased to around 30 years in contemporary society, this extended time frame has become impractical for defining a generation. In the present day, there is a widely accepted sociological definition that identifies a generation as spanning 15 years. This conceptualization offers a more systematic approach to defining each generation, eliminating the reliance on specific events or unforeseen circumstances to demarcate the beginning or end of a generation. The 15-year timeframe precisely outlines the commencement and conclusion of a generation, providing a structured basis for future planning and facilitating more accurate comparisons across different generations. Generational analysis has gained prominence as a mainstream discipline in both sociology and academia. Its significance extends beyond scholarly pursuits, becoming crucial for businesses to navigate successfully. Understanding the intricacies of each generation is pivotal for organizations to effectively engage, communicate, connect, and tailor products or services to diverse age groups. Failure to grasp and adapt to the distinct characteristics of each generation could lead organizations down a path of irrelevance and potential extinction. In essence, the ability to comprehend and cater to the needs and preferences of various generations has become a determining factor for the survival and relevance of businesses in today's dynamic landscape. This review tries to compare differences and similarities among Generations X, Y and Z.

Generation X, encompassing those born between 1965 and 1979 and coined by Douglas Coupland, embodies an antiestablishment ethos and a tendency to resist authority. Like the Baby Boomers, many actively engage in property ownership, doing so at a younger age. Prior to the advent of COVID-19, Generation X thrived during a period of economic prosperity, enabling them to embrace small business and entrepreneurial opportunities. Despite initial challenges, this generation has flourished, establishing themselves economically with a notable acceleration in net worth since the early nineties. Their resilience and unique approach distinguish them, shaping their contributions to both societal and business dynamics (Corporativa, n.d.). Generation Y, or Millennials (1980-1994), known for their affinity for "smashed avo," specialty coffee, and global travel, faces significant housing market challenges due to soaring prices and stagnant wages. Shaped by the events of September 11, 2001, during their formative years, Millennials now, in their 30s and 40s, are entering the phases of parenthood and family life, reflecting the broader societal shifts that have defined their generation (Twenge, 2023; Prakash & Tiwari, 2021). Generation Z, born between 1995 and 2009, has evolved in the backdrop of the COVID-19 era, adapting to economic uncertainties with a more conservative and resilient mindset. Emphasizing the importance of education, they recognize its foundational role and adopt a proactive approach to upskilling and retraining, rejecting the traditional concept of a job-for-life in Favor of a lifelong learning ethos. Contrary to stereotypes, this generation displays a strong work ethic, engaging in volunteerism at a higher rate than the average Australian and often choosing non-profit work for its alignment with their values and desire for fulfilment (Colic-Peisker & Johnson, 2010). While prioritizing making a positive impact over mere earnings, Generation Z maintains financial conservatism, diligently saving for homeownership and holding onto the 'great Australian dream,' with the fear of housing unaffordability ranking high among their concerns (Molloy, 2024; Barhate & Dirani, 2022).

SELECTIVE ATTENTION AMONG GENERATIONS

The term "stimuli" can refer to various types of environmental inputs or influences that organism, including humans, encounter. Changes in stimuli over generations can be influenced by a variety of factors, including technological advancements, cultural shifts, and environmental changes. Here are some general trends that may describe how stimuli and their amounts have changed over generations:

Technological Advancements

With each generation, technology tends to become more advanced and complex. This leads to an increase in the variety and intensity of stimuli. For example, the transition from agricultural societies to industrial societies and then to information societies has brought about significant changes in the types and number of stimuli-individuals encounter(Kumar, 2020).





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Media and Communication

The advent of the internet and digital media has resulted in an explosion of information. This has led to an increase in the volume of stimuli individuals are exposed to on a daily basis. Social media, news outlets, and online platforms contribute to a constant stream of information (Karim, n.d.).

Cultural and social changes

As societies evolve, cultural norms and social structures change. This can lead to shifts in the types of stimuli individuals experience. For instance, changes in societal attitudes toward diversity and inclusion may expose individuals to a broader range of perspectives and experiences(Attias-Donfut, 2000).

Environmental Changes

The shift from rural to urban living has altered the types of stimuli people encounter. Urban environments often provide a different set of sensory inputs compared to rural or natural settings. This shift can impact individuals' experiences and perceptions of the world around them (Krajina, 2018).

Educational and work environments

Changes in educational and occupational structures can result in individuals being exposed to stimuli that are more specialized. As societies become more specialized in various fields, people may encounter stimuli that are specific to their areas of expertise(Stevens & Bavelier, 2012; Boyd, 2022).

Globalization

Increased globalization has facilitated the exchange of ideas, cultures, and traditions across borders. This has led to a blending of stimuli from different parts of the world, contributing to a more interconnected global culture. It's important to note that these trends are generalizations, and there can be significant variability among different individuals, communities, and regions. Additionally, the impact of changes in stimuli on individuals can vary depending on factors such as personal preferences, adaptability, and coping mechanisms (Lev-Ari et al., 2022). Research aimed to scrutinize the consumption habits of residents in South East Queensland (SEQ) and assess potential intergenerational differences, leveraging the region's recent surge in immigration and its designation as a classic sunbelt area. Notably, the study identified generational patterns in consumption, finding commonalities in 'common goods' consumption among all generations, except for Generation Y (Gen Y). While 'public goods' consumption showed non-significant differences, Gen Y exhibited distinct preferences in 'new leisure' activities, including increased online engagement, theme park visits, and higher takeaway dinner consumption, indicative of their tech-savvy and busy lifestyles. Contrarily, older generations like Pre-BB and Baby Boomer (BB Gen) leaned towards 'experiential' consumption, favouring live theatre or opera despite historical challenges. The study challenged conventional materialist and post-materialist divisions, proposing a nuanced perspective where each generation shared and differentiated consumption elements based on cultural-aesthetic and time-space dimensions. Interestingly, it suggested a potential return to materiality in Generations X and Y, implying a blend of materialist and post-materialist values shaped by globalized and virtual consumption. Younger generations displayed a contraction of space and time in their consumption habits, while older generations upheld classic consumption tendencies. Despite indications of a shift towards postmodern forms, the research underscored the persistence of classic consumption, tempering notions of a significant cultural transformation (Chhetri et al., 2014).

INFLUENCING FACTORS

Motivation

While motivation can vary among the individuals of each generation, the generalized characteristics mentioned here may not apply to everyone in those generations. There is a change in trends that influence motivation in the three generations discussed here. The Generation X time period is the period when industrialization and globalization started, hence the need for more workers. This influenced the individual to improve their adaptation capabilities. Since Generation X was raised in an unpredictable and challenging economic environment, they are frequently





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realistic and practical. They could be inspired by observable outcomes, practical goals, and problem-solving strategies. Their parents' hard work had an impact on their children's ability to value their time outside of work and maintain a work-life balance. For Generation X, career advancement and stability were critical. The chance to grow professionally and acquire new abilities could have inspired them. Generation Y, also known as Millennials, is often motivated by purpose in life and work. Millennials are very motivated to learn new things and grow as individuals. Opportunities to learn new skills, participate in training courses, and pursue professional growth are what drive them to stay relevant in a world that is changing quickly. Millennials' motivation is frequently derived from being able to contribute to a creative and dynamic work environment in which ideas can be openly exchanged. They expect regular feedback and recognition from their peers. Constructive input that helps individuals develop, as well as recognition for their efforts for the team or organization, inspires them. The millennial generation is the first to have grown up with advanced technology. Workplaces that welcome innovation, provide access to cutting-edge technologies, and exploit technology for efficiency motivate them. Tailoring workplace regulations, benefits, and corporate culture to these ideals can help encourage and satisfy Millennial workers. Generation Z has distinct features and motives that have been influenced by their unique experiences as well as the quickly changing environment around them. This generation is the first to have grown up with technology integrated effortlessly into their daily lives. Generation Z is sophisticated in technology and extremely connected. Opportunities to harness technology, work remotely, and interact with the digital world may provide motivation. A lot of individuals in Generation Z think like entrepreneurs(Ratajczak, 2020). They may be driven by a desire to launch their own companies or follow creative ideas because they value freedom. Because technology and the labour market are changing too quickly, positions that enable Generation Z to swiftly learn new skills, adapt to changing industry trends, and stay ahead of the competition are what motivate them(Mahmoud et al., 2021).

A study from the department of technology management and business at the University Tun Hussein Onn Malaysia identifies the motivating elements for Gen X and Gen Y workers in Malaysia's electric and electronic sectors. This study included 124 respondents in total, chosen by cluster sampling. According to this study, there are some discrepancies between the intrinsic and extrinsic motivation aspects of generations X and Y. According to their research, Generation X was comparatively more highly motivated by intrinsic (work, achievements, recognition, promotion) and extrinsic factors (work condition, company policy and administration, pay and benefit) than Generation Y (Tan, 2012). Another research article from the Journal of Human Recourse Management Research by Cracow University of Economics, Cracow, Poland, gives a comparative study on financial and non-financial factors in generations X, Y, and Z. It states that the financial motivation in all three considered generations is greater than the non-financial factors (Bielińska-Dusza, 2022). Selective attention that is in line with their professional and personal objectives may be shown by Generation X. Tasks that support stability and balance over the long run might be given priority. Millennials have the tendency to focus only on assignments that are in line with their values and present chances for growth and learning. Because of their need for self-expression and connectivity, members of Generation Z may display selective attention patterns that give priority to digital interactions and creative outlets. Attention distribution may be impacted by motivation influenced by social factors. Gen Z's selective attention may be influenced by their increased sensitivity to social trends and online interactions.

Stress

Generation to generation, stress is a shared experience, yet its causes and effects can differ. Since those from Generation X frequently combine job and family duties, they may face stress connected to finding a work-life balance. Financial worries such as home payments, child education savings, and retirement planning may cause stress for this generation as they enter the workforce during an economic downturn and face job instability and stagnant pay. Having grown up during the technological revolution, Generation X has had to adjust to the growing digitization of the workplace. This adjustment may cause stress, particularly if they feel compelled to keep up technologically with younger generations. Economic recessions, global events, and changes in society can all have a substantial impact on job security and financial stability, causing stress among this generation. The Millennials navigating their early employment is their large student loan burden. Rising housing costs, especially in cities, might





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put Millennials under financial pressure and hinder their ability to attain classic success markers like homeownership. Even though mental health issues are becoming more widely recognized and less stigmatized, Millennials may still encounter obstacles when it comes to asking for help or having open conversations about mental health in the workplace. Some millennials have encountered financial difficulties as a result of ensuing downturns, having entered the workforce during or soon after the 2008 financial crisis. A further layer of stress has been added by occurrences like the COVID-19 epidemic, which have affected mental health, disrupted work patterns, and created uncertainty. Since gig economy jobs, part-time work, and short-term contracts have become increasingly common, millennials may face job uncertainty. Stress levels may rise due to millennials' expectations of ongoing availability and response at work, as they feel under constant pressure to stay connected. Social media, which millennials grew up with, can cause stress because of the need to portray a well-curated, successful online personality and ongoing social comparison. Millennials could feel the pressure of being compared to earlier generations, especially when it comes to succeeding. Stress in Generation Z is even worse than in other generations. With high expectations for academic performance, Generation Z frequently faces severe academic pressure. Stress can be exacerbated by the need to compete in a worldwide labour market and ensure a bright future. For many members of Generation Z, the competitive nature of college admissions and the emphasis on pursuing a higher education can be a significant source of stress. Regular exposure to well-chosen photos and events on social networking sites can cause emotions of inadequacy and social comparison, which in turn can increase stress. Their mental health may be impacted by the cyberworld's exposure to cyberbullying, online harassment, and derogatory remarks. Some members of Generation Z may experience financial concerns like student loan debt, housing affordability, and economic downturns, much like Millennials did. There has been an increase in awareness and knowledge of mental health issues among Generation Z(The Annie E. Casey Foundation, 2021). Although this is a good thing, raising awareness of mental health issues and the stigma associated with them can also make people more stressed. Unprecedented difficulties, such as disruptions to education, future uncertainty, and health and safety issues, have been brought about by events such as the COVID-19 pandemic(Marshall &Wolanskyj-Spinner, 2020).

Many refer to Generation Z as the generation affected by climate change, and the impending environmental catastrophe might exacerbate existential stress and future concern. To compete in a job environment that is changing quickly, some members of Generation Z can feel pressure to specialize early in a certain skill or career path. Since 2007, an annual survey regarding Americans' stress levels has been issued by the American Psychological Association (APA). All things considered, 2020 was an especially difficult year because of the epidemic and political instability. Therefore, the survey's findings of abnormally high stress levels did not surprise anyone. You might be surprised to learn who expressed the most stress: the Z generation. On a scale of one to ten, generations reported the following degrees of stress: 75 and over: 3.3; Baby Boomers: 4.0; Gen X: 5.2; Millennials: 5.6; and Gen Z: 6.1 (LifeStance Health, 2023). A comparative study between Generation Y and Generation Z based on managing stress in active employment in the active Polish market was published in January 2022 in ResearchGate (Pangsy-Kania, 2022). It had been determined that there are only significant variations between Generations Y and Z when there is intense competition at work. Men and women from generation Y see things like poor relationships among coworkers, unfair treatment by supervisors, and fierce competition in the workplace differently, according to separate research for each age. Women are more likely than men to endure stress as a result of these events. Regarding Generation Z, the only notable distinction between the responses from men and women concerned work overload, which adversely impacted women (Panigrahi, 2017). Career and financial demands, academic pressures, and financial stress management Digital overload and technological stress can cause divided attention, making it difficult to focus on tasks. Job uncertainty can cause increased alertness and distraction as employees examine their workplace for signals of stability or instability. Global events might cause heightened awareness and distraction, impairing one's capacity to focus on specific tasks. The need to be up-to-date on current events may contribute to divided attention and information processing difficulties. Effective coping skills can help reduce the negative impact of stress on selective attention, supporting more concentration and focus.





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Information and communication

Generations X, Y, and Z's selective attention is impacted in different ways by the way information is shared and communicated, which has changed significantly over time. Traditional forms of communication were replaced by electronic ones, such as email and the early internet, which Generation X experienced. They were among the first to adapt to the digital revolution(Calvo-Porral& Pesqueira-Sanchez, 2019). Their early exposure to digital communication may have affected their selective attention behaviors. The emergence of instant messaging services and social media platforms was witnessed by millennials. They are renowned for being the first generation to adopt new technology wholeheartedly and incorporate it into their everyday routines. Since they grew up with smartphones, social media, and rapid access to information, Generation Z is regarded as real digital natives (PatientMetRx®, 2021). They are used to living in a technologically advanced, highly linked world. Individuals from Generation Z may be skilled at multitasking and managing several information sources at once. This may have an effect on their ability to pay selective attention, enhancing their speed at evaluating and prioritizing information. Traditional text-based information may not be able to hold the interest of readers compared to visual content (Roberto, 2023). It's possible that Generations Y and Z have faster processing speeds for visual inputs. An expectation of quick satisfaction has been promoted by the availability of information at one's fingertip (NDMU, 2019). This may be a factor in people's decreased attention spans, particularly in Gen Z and Millennials. Comprehending the communication styles and technology settings of every generation offers a valuable understanding of the ways in which these elements influence selective attention patterns.

Perceptual loads

According to perceptual load theory, the amount of perceptual information to be processed in a given task determines the allocation of selective attention. It is possible that individuals from Generation X acquired their capacity for selective attention in a setting with moderate perceptual burdens. They kept up with the growing digitization of information, but they did not fully engage with the complex, multimodal material of today. Millennials' increased exposure to visual imagery, multimedia, and information on the internet probably increased their perceptual load. A new layer of perceptual indications was introduced by social media, which affected how people processed and focused their attention on different kinds of content. Because they are constantly exposed to visually stimulating and dynamic content on social media, streaming services, and other digital channels, Gen Z members are probably used to high perceptual loads. Their selective attention habits may be influenced by their capacity to navigate through a variety of visual stimuli. Although they may have become accustomed to early multitasking techniques, Generation X did not have the same immersed or linked experience with technology as subsequent generations had. With the proliferation of smartphones and their capacity to interact with numerous digital platforms at once, millennials have had to learn how to manage the difficulties associated with multitasking. Gen Z individuals are true digital natives who probably developed their multitasking abilities at a young age by juggling multiple media platforms at once. They might have refined their perceptual load management to handle various information streams simultaneously (Remington et al., 2014). Personal variations within each generation, however, have a substantial effect on developing perceptual load preferences and attentional responses.

FUTURE PERSPECTIVE

The future holds the promise of even more immersive and interactive technologies, such as augmented reality (AR) and virtual reality (VR). These advancements may reshape how individuals direct their attention, blurring the lines between the physical and digital worlds. The ability to seamlessly transition between virtual and real environments could influence attentional patterns, with individuals navigating a complex interplay of stimuli. The future trajectory of selective attention is intricately tied to the evolution of social media platforms. While Millennials played a significant role in the rise of platforms like Facebook and Instagram, Generation Z is pushing the boundaries with platforms like TikTok and Snapchat, characterized by short-form videos and visually engaging content. As social media continues to evolve, the attentional demands placed on users are likely to intensify. Generation Z, in particular, is accustomed to processing information in rapid-fire bursts, and this may translate into a preference for succinct, visually compelling content. The impact of these trends on attention spans and the ability to focus on more extended, complex information remains a key area for exploration(Howarth, 2022). In the future, we may see a





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continued trend toward multitasking, with individuals juggling multiple information sources simultaneously. While multitasking has become a hallmark of the digital age, its long-term effects on cognitive load and selective attention are subjects of ongoing research. Generations Y and Z, raised in an environment where switching between tasks is normal, may develop enhanced multitasking abilities. However, questions arise about the potential trade-offs, such as reduced depth of focus and increased susceptibility to distraction. Balancing the benefits and drawbacks of multitasking will be crucial for understanding the future landscape of selective attention(Kaminske, 2020). As society becomes more aware of the importance of mental health and well-being, there is a growing recognition of individual differences in attentional patterns(Lev-Ari et al., 2022). The future perspective on selective attention involves understanding how cultural shifts and societal attitudes toward neurodiversity influence attentional norms. Generational differences in selective attention may also become more nuanced as individuals challenge stereotypes and embrace diverse cognitive styles. Accommodations for attentional differences, such as ADHD, may become more personalized, fostering environments that support individuals in leveraging their unique strengths. In the future, the interplay between technological advancements, societal changes, and individual characteristics will continue to shape the landscape of selective attention among Generations X, Y, and Z. Understanding these dynamics is crucial for educators, employers, and policymakers seeking to create environments that optimize attentional capacities. As we navigate this ever-evolving landscape, the future perspective on selective attention invites a thoughtful exploration of how we can harness the benefits of technological progress while safeguarding the cognitive well-being of individuals across generations. By fostering a balanced approach that embraces individual differences and promotes mindful engagement with information, we can ensure that the future of selective attention is both adaptive and enriching.

CONCLUSION

In conclusion, this review delves into the nuanced dynamics of motivation, stress, information processing, and attentional patterns across Generations X, Y, and Z. While Generation X is motivated by practical outcomes and adaptability, Millennials seek purpose and continuous learning, and Generation Z is driven by technology and entrepreneurial aspirations. Stressors vary across generations, with financial pressures impacting Millennials, academic stress affecting Generation Z, and Generation X grappling with work-life balance and technological adaptation. The study also explores how communication methods, perceptual loads, and the prevalence of ADHD have evolved over generations, anticipating continued shifts influenced by immersive technologies and changing social media platforms. As societal awareness of mental health grows, accommodating attentional differences becomes crucial, requiring educators, employers, and policymakers to adapt environments for optimal cognitive well-being across diverse generations in the face of technological advancements and cultural shifts.

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RESEARCH ARTICLE

Developed a Hybrid Fast Correlation-based Feature Selection with Improved Weighed Particle Swarm Optimization to Predict and Classify Heart Disease at an Early Stage

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ABSTRACT

One of the applications of ML is the forecasting of heart disease. Optimization methods have the benefit of being able to cope with complicated non-linear issues while remaining flexible and adaptable. In this study, we used the Fast Correlation-Based Feature Selection (FCBFS) approach to remove duplicate characteristics from heart disease classification. Then, an analysis using various classification algorithms especially Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Random Forest (RF), Multiplayer Perception (MLP), Naive Bayes (NB), and Artificial Neural Network (ANN) optimized using Improved Weighed Particle Swarm Optimization (IWPSO). The proposed combined technique is used in a heart condition database; the findings show that the proposed combination of methods is effective and durable in handling different kinds of information for heart disease identification. As an outcome, this research evaluates various ML algorithms and analyses the outcomes using various metrics such as Accuracy, Precision, Recall, F1-score, and Sensitivity. Using the optimized approach proposed by IWPSO and





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FCBFS achieved an optimal accuracy in classification of 99.65%. The outcomes reveal that the proposed system outperforms the previously existing classification method.

Keywords: Heart disease, Artificial Neural Network, K Nearest Neighbor, Support Vector Machine, Naïve Bayes, Random Forest, Classification, Feature selection, Ant Colony Optimization, Particle Swarm Optimization, Machine Learning

INTRODUCTION

In today's environment, Cardio Vascular Disease (CVD) is on the rise. The World Health Organization (WHO) estimates that 17 million people die every year as a result of cardiovascular illness, primarily strokes and heart attacks [1]. When an individual's condition is serious meaning that he or she needs to start taking medicines right away, this analysis might be lengthy and time-consuming, and so it's crucial to prioritize it [2]. CVD is caused by a variety of unhealthy practices. As a result, it is also vital to understand which behaviors regarding health lead to CVD. With the increasing quantity of information, ML has become a developing field. ML enables the acquisition of information from huge amounts of information that would be difficult and occasionally unattainable for humans [3]. The goal of this research is to prioritize tests for diagnosis and look at some of the risk factors for CVD. As part of this paper, 70% of the information is monitored or trained and 30% is tested using a method based on ML called classification. Smart optimization techniques are widely employed in numerous study disciplines [4, 5]. It is built by exposing specific events in nature. In basic nature and versatility, the PSO method has been effectively used for heart disease [6]. Furthermore, the ACO method was initially developed for combinatory optimization. Algorithms for ACO were recently created to handle continuous optimization challenges [7]. When tackling complicated issues, using a single optimization approach has the drawbacks of inadequate precision and generalization. The FCBFS technique [8] is employed in this paper to eliminate unnecessary and unimportant characteristics, the PSO optimization outcomes are used as the initial values of the ACO, and then a classification framework for heart disease is created after the variables are modified.

Problem statement

The FCBFS technique was used as the initial phase (pre-treatment) in this study. The optimum collection of features chosen by the feature selection techniques increases the precision of classification. The primary goal of this paper is to anticipate heart disease using various classification algorithms. Weak information-mining technology is employed to analyze heart disease information. This paper's primary achievements are as follows: Extract of categorized reliability helpful in predicting heart disease, Using the FCBFS approach, eliminate duplicate and unimportant characteristics. Optimization of IWPSO methods is then considered. On the heart disease information set, multiple methods of data mining are compared. Identifying the best performance-based method for predicting heart disease. The rest of the article is structured as follows. Section 2 discusses current research in this field. Section 3 provides a full explanation of the proposed method. Section 4 describes testing that was performed with the proposed ML systems. Section 5 concludes with findings and additional study objectives.

RELATED WORK

Multiple analyses of health information sets are carried out, employing multiple classifiers and choosing feature strategies. The classification of the heart disease database has received little attention. Many of them demonstrate high classification reliability [9]. [10] Proposed a combination technique that successfully combines two AI computations, SVM and Genetic Algorithm (GA) with the wrapping method. This technique's outputs are analyzed using the LIBSVM and the WEKA information mining tools. Proposed an evaluation and follow-up mechanism. The proposed method recognizes and tracks coronary artery disease. Used automated methods of learning to diagnose cardiac problems in patients with diabetes. The Chennai Research Institute's gathering of information on 500 patients





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is utilized. There are 142 persons with the disease and 358 patients who do not. The NB method has 74% efficiency. SVM has the greatest efficiency (94.60%). Proposed that information analysis technologies be used to diagnose heart disease. The NB method was used to identify coronary artery disease. In the case of NB theorem is applied. As a result, NB has a strong principle of autonomy. The information that was used came from one of Chennai's major diabetic studies. Conducted an analysis that used a hybrid classification approach depending on the ReliefF and Rough Set (RFRS) technique to aid in the detection of coronary artery disease.

PROPOSED METHODOLOGY

Figure 1 depicts the main architecture of the proposed system. Dataset of heart disease from UCI repository is given to preprocessing (Handling of missing values, elimination and feature selection, Normalization and Resample) the data. Heart disease dataset is trained using binary classification and Feature Selection is the method of reducing the input variable to our model by using only relevant data. The preprocessed data is trained using machine learning algorithms and tested with 10 iterations. The Proposed Hybrid algorithm is the process where we train the model iteratively that results in a maximum and minimum function evaluation. After 10th iteration, the result is cross validated and predicted the disease. Characteristics are chosen from the initial data set, then the most effective selection of characteristics is optimized using hybrid method. The other side the trained dataset should be tested, preprocessed using normalization and classified. Finally the result produced based on performance measures. The attributes of the heart disease datasets of the patients depicted in Table 1.

Preprocessing

Preprocessing is a technique for obtaining full, constant, and readable data. The accuracy of information influences the mining results achieved by ML systems. Insignificant variables can degrade model performance and diminish the learning rate. As a consequence, choosing characteristics is important in preprocessing since it selects the characteristics which contribute the most to forecasting the intended output. Furthermore, because the mean maintains a characteristic's extremes, values that are missing in the FHS database are substituted by an attribute's mean, as illustrated in Equation (1).

Attribute Mean =
$$\frac{\sum_{x=0}^{l} (attribute \ value \)x}{l} \qquad \qquad \dots \dots (1)$$

Where i is the total amount of attributes with values

The data set's goal class forecasts the possibility of Coronary Heart Disease (CHD). The probability of a person who is more likely to suffer from CHD is 15.2% (644 out of 4240 entries), whereas the probability of a person who does not suffer from CHD is 84.8% (3596 out of 4240 entries). Figure 3 displays an illustration of the steps in sequence used in the study that was proposed.

Dataset and attributes

The information was gathered from the UCI ML library. The Heart Disease data set is the name of the data set, which can be obtained from the repository for ML at UCI. The UCI ML collection offers an extensive and varied collection of datasets from several disciplines. The repository has been used for a variety of academic papers and research projects.

Classification Task

Heart disease detection can be viewed as a classification or clustering challenge in the context of AI. On the other together, we created a framework based on a large set of both present and absent files information, allowing us to reduce the issue to classification.

Feature selection

This expression information contains a significant number of useless and redundant features; the process of classifying heart disease becomes increasingly difficult.





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Improved Weighed Particle Swarm Optimization

The algorithm's idea is to shift these small particles until they find the optimal position. Every one of those particles possesses shown in Figure 2:

Step 1: From a place in the defining set, i.e. the coordinate's particle's speed at which it can move.

Step 2: As a result, every particle's location varies during the repetitions based on weight. It evolves based on its best neighbor, greatest position, and prior location.

Step 3: This evolution is what allows us to discover the best component.

Step 4: A neighborhood or a group of atoms that interact with the particle right away, particularly the one with the most favorable criterion. At any one time, every single particle understands:

Step 5: The value is given to the objective function because every iteration necessitates an assessment between the present particle's amount of the criteria and the value that is optimal.

The findings are displayed in Table 2 with optimization. The effect of simulation inaccuracy is additionally taken into account in this work to enhance the evaluation of the performance of classifiers. To accomplish so, we assess our classifier's efficiency in terms of Kappa as a randomly adjusted indicator of the agreement among categories in addition to real courses, Absolute mistake is defined as how guesses or forecasts resemble potential results. Root Relative Absolute Error, Root Relative Squared Error, Root Mean Squared Error, and Relative Absolute Error are all examples of errors. Table 3 displayed the analysis of classifier performance measures based on hybrid FCBH with IWPSO

Experiments and results

The next part goes over the data sets, tests, and assessment systems for heart illnesses. The Waikato Environment for Knowledge Evaluation (Weka) is used in this analysis.

Classification results

The overall goal of the experiment was to see which algorithm best classified heart disease using the provided optimization approaches. Figure 3 and 4. To avoid unstable operation outcomes, every test was conducted ten times, and the best classification accuracy was chosen for comparison.

- 1. Classifiers that are not optimized
- 2. FCBFS-optimized classifiers
- 3. FCBF with IWPSO-optimized classifiers

The findings are displayed in Figure 3 with optimization. The effect of simulation inaccuracy is additionally taken into account in this work to enhance the evaluation of the performance of classifiers. To accomplish so, we assess our classifier's efficiency in terms of Kappa as a randomly adjusted indicator of the agreement among categories in addition to real courses, Absolute mistake is defined as how guesses or forecasts resemble potential results. Root Relative Absolute Error, Root Relative Squared Error, Root Mean Squared Error, and Relative Absolute Error are all examples of errors. Figure 4 displayed the analysis of classifier performance measures based on hybrid FCBH with IWPSO Table 4 shows the comparison of performance measures (TP Rate, FP Rate, Precision, Recall, F-Measure) based on 3 classes i) without optimization ii) with FCBFS optimization and iii) with our proposed system for five machine learning algorithms. And it proves that our proposed FCBFS-IWPSO system produces higher accuracy than other two methods.

CONCLUSION AND FUTURE WORK

This research aimed to use AI to compare methods using various performance metrics. For test forecasting, all data were pre-processed. In certain situations, every algorithm performed better than the others. Thus, when contrasted to other current techniques, the evaluation section amply illustrated the efficacy of hybrid FCBFS-IWPSO approaches to identifying diseases. With KNN and RF the proposed optimized model by FCBFS-IWPSO achieves a precision score of 99.65%. This research can serve as a starting point for learning how to diagnose heart disease via autonomous learning, and it can be expanded upon for future studies. The research being conducted has several





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constraints, including the knowledge base of the writer, the tools employed, such as the computer's processing capacity, and the time allotted for the research. Modern tools and subject-matter expertise are needed for this kind of research. Various algorithms fared better in each of the columns previously, based on whether calibration, feature, cross-validation, and grid search selection were utilized or not.

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Table 1: Attributes of the Heart disease dataset

Attribute	Information Attribute	Description
Age	Integer	Age in years(29 to 77)
Sex	Integer	Gender instance (0=Female,1 =Male)
Chest Pain Type	Integer	Chest pain type(1:typicalangina,2:atypicalangina,3: non- anginalpain,4:asymptomatic)
Rest Blood Pressure Integer		Resting blood pressure in mmHg[94,200]
Serum Cholesterol	Integer	Serum cholesterol in mg/dl[126,564]
Fasting Blood Sugar	Integer	Fasting blood sugar >120 mg/dl(0=False,1=True)
ResElectrocardiographic	Integer	Resting ECG results (0:normal,1:ST-Twave abnormality,2:LVhypertrophy)
Max Heart Rate	Integer	Maximum heart rate achieved [71,202]
Exercise Induced	Integer	Exercise-induced angina(0:No,1:Yes)
Old peak	Real	ST depression induced by exercise relative to rest[0.0, 62.0]





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Slope	Integer	The slope of the peak exercise ST segment (1: up-sloping, 2:flat,3:down-sloping)
Major Vessels	Integer	Number of major vessels colored by fluoroscopy(values 0-3)
Thal	Integer	Defect types:value3:normal,6:fixed defect,7: irreversible defect
Class	Integer	Diagnosis of heart disease(1:Unhealthy,2:Healthy)

Table 2. Classifiers Performance optimized by FCFB

Evaluation criteria	K- NN	SV M	RF	NB	ML P
Time to build a model (s)	0.02	0.07	0.04	0.03	0.5
Correctly classified instances	272	227	270	234	247
Incorrectly classified instance	2	45	2	39	25

Table 3. Classifiers Performance optimized by FCBF with IWPSO

Evaluation criteria	K- NN	SV M	RF	NB	ML P
Time to build a model (s)	0.02	0.10	0.56	0.03	0.59
Correctly classified instances	214	226	219	226	226
Incorrectly classified instance	59	46	55	45	45

Table 4: Accuracy measured by class

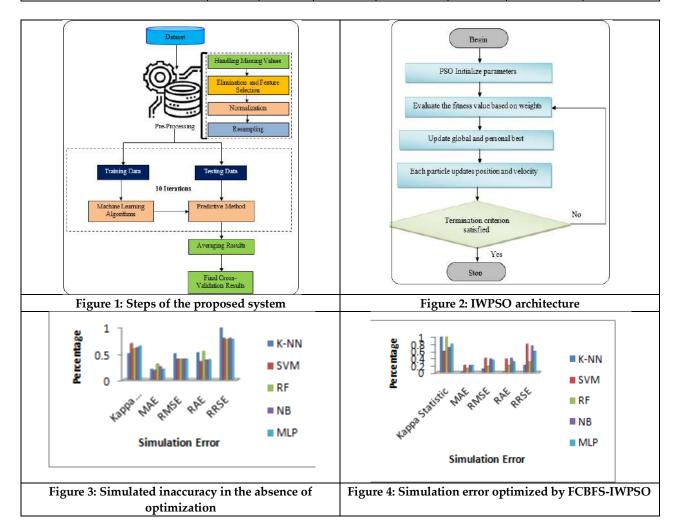
Table 4: Accuracy measured by		TP Rate	FPRate	Precision	Recall	F- Measure	Class
	K- NN	0.853	0.358	0.885	0.853	0.869	Absence
		0.842	0.347	0.806	0.842	0.824	Presence
	SVM	0.967	0.3	0.944	0.967	0.955	Absence
Classifiers without		0.9	0.233	0.928	0.9	0.914	Presence
optimization	RF	0.947	0.325	0.925	0.947	0.936	Absence
optimization		0.875	0.253	0.902	0.875	0.888	Presence
	NB	0.967	0.3	0.944	0.967	0.955	Absence
		0.9	0.233	0.928	0.9	0.914	Presence
	MLP	0.933	0.292	0.945	0.933	0.939	Absence
		0.908	0.267	0.895	0.908	0.902	Presence
	K- NN	0.933	0.375	0.891	0.933	0.912	Absence
		0.825	0.267	0.877	0.825	0.85	Presence
	SVM	0.96	0.3	0.943	0.96	0.951	Absence
		0.9	0.24	0.921	0.9	0.91	Presence
Classifiers optimized by FCBFS	RF	0.947	0.35	0.909	0.947	0.927	Absence
rebra		0.85	0.253	0.896	0.85	0.873	Presence
	NB	0.973	0.3	0.945	0.973	0.959	Absence
		0.9	0.227	0.935	0.9	0.917	Presence
	MLP	0.987	0.317	0.936	0.987	0.961	Absence
		0.883	0.213	0.947	0.883	0.914	Presence
Classifiers optimized by	K- NN	1	0.018	0.996	1	0.999	Absence
FCBFS-IWPSO		0.998	0	1	0.995	0.995	Presence
FCDF3-1W1 3O	SVM	0.96	0.292	0.949	0.96	0.954	Absence
		0.808	0.14	0.822	0.808	0.815	Presence





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RF	0.993	0	1	0.993	0.997	Absence
	1	0.007	0.992	1	0.996	Presence
NB	0.907	0.2	0.85	0.907	0.877	Absence
	0.8	0.093	0.873	0.8	0.835	Presence
MLP	0.96	0.15	0.889	0.96	0.923	Absence
	0.85	0.04	0.944	0.85	0.895	Presence





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RESEARCH ARTICLE

Solid Waste Management for Societal and Environmental Betterment in India

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ABSTRACT

The goal of this paper is to concentrate on the ongoing practices connected with the different waste administration drives taken in India for human prosperity. The other object is to give a few ideas and suggestions to further develop the waste administration rehearses in Indian towns. This paper be subject to on optional exploration. Existing reports connected with waste management and recommendations of organizers/NGOs/expert's/government concernbureaus / key industry professionals for further developing the framework are considered. It offers profound information about the different waste administration drives in India and figure out the degree for development in the administration of waste for the government assistance of the general public. The paper endeavours to comprehend the significant pretended by the conventional area participated in waste management in our country.

Keywords: India, waste management, recycle, waste disposal,

INTRODUCTION

"There are not many things sure throughout everyday life - one is demise, second is change and the other is Waste." Nobody can shut down these things to happen in our lives. Yet, with better administration we can set ourselves up. Here we will discuss endlessly Waste the board. Every one of us has an option to clean air, water and food. This right can be satisfied by keeping a reasonable and solid climate. Presently for the primary inquiry, what is Waste? Any material which isn't required by the proprietor, maker or processor is Waste. For the most part, Waste is characterized as toward the finish of the item life cycle and is discarded in landfills. Most organizations characterize Waste as "whatever doesn't make esteem" (BSR, 2010). In an everyday person's eye whatever is undesirable or not





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helpful is trash or waste. Anyway deductively talking there is no loss as such on the planet. Practically every one of the parts of strong waste have some potential on the off chance that it is changed over or treated in a logical way. Consequently, we can characterize strong waste as "Natural or inorganic waste materials delivered out of family or business exercises, that have lost their worth according to the principal proprietor yet which might be of incredible worth to another person." (Robinson, W.D.1986). Age of waste is unavoidable in each home howsoever enormous or little. Starting from the beginning of progress mankind has slowly strayed from nature and today there has been an extreme change in the way of life of human culture. Direct impression of this change is tracked down in the nature and amount of trash that a local area creates. We can arrange the waste or reuse the waste and can bring in cash through appropriate administration. Indian urban communities which are quick contending with worldwide economies in their drive for quick monetary improvement have so far neglected to really deal with the enormous amount of waste produced. There are around 593 locales and roughly 5,000 towns in India. Around 27.8 percent of India's absolute populace of more than 1 billion (according to Registration 2001) lives in metropolitan regions. The projected metropolitan populace rate is 33.4 percent constantly 2026. The quantum of waste created in Indian towns and urban areas is expanding step by step because of its rising populace and expanded Gross domestic product. The yearly amount of strong waste produced in Indian urban communities has expanded from 6,000,000 tons in 1947 to 48 million tons in 1997 with a yearly development pace of 4.25 percent, and it is normal to increment to 300 million tons by 2,047 (CPCB, 1998). Populace blast, combined with further developed way of life of individuals, brings about expanded age of strong Wastes in metropolitan as well as rustic region of the country.

In India like any remaining areas there is an undeniable qualification between the strong waste from metropolitan and provincial regions. Notwithstanding, due to steadily expanding urbanization, quick reception of 'purpose and toss concept'& similarly quick correspondence between metropolitan and provincial regions the hole between the two is decreasing. The strong waste from country regions is all the more a biodegradable nature and the equivalent from metropolitan regions contains more non-biodegradable parts like plastics and bundling. The repulsive mentality towards strong waste and its administration is notwithstanding, normal in both the areas. Generally, 'making trash far away' is the ordinarily followed practice. In India, the metropolitan neighbourhood bodies, prominently known as the civil companies/boards, are liable for the executives of exercises connected with general wellbeing. In any case, with expanding public and political mindfulness as well as additional opportunities opened by financial development, strong wastemanagement is beginning to get due consideration. The different drives taken by government, NGOs, privately owned businesses, and nearby open definitely expanded in the beyond couple of many years. Regardless, land filling is as yet the predominant strong waste administration choice for the US as well as numerous different nations like India all over the planet. It is notable that Waste the executive's strategies, as they exist presently, are not maintainable in the long haul. Accordingly, Waste the executives is going through intense change to offer more choices that are more maintainable. We check out at these choices in the desire for offering the waste administration industry an all the more monetarily feasible and socially OK answer for our ongoing waste administration situation. This paper frames different advances in the space of waste administration. It centres around current practices connected with Waste the board drives taken by India. It additionally features a few drives taken by the US central government, states and industry gatherings. The motivation behind this paper is to acquire information about different drives in the two nations and find the extension for development in the administration of waste.

Solid Waste Classification

There might be various kinds of waste, for example, Home-grown waste, Manufacturing plant Waste, Waste from oil production line, E-Waste, Development Waste, Rural waste, Food handling waste, Bio-clinical waste, Atomic waste, Butcher house Waste etc. We can arrange Waste as follows:

- Solid waste-vegetable waste, kitchen Waste, family Waste and so forth.
- E-Waste- disposed of electronic gadgets, for example, PC, television, music frameworks and etc.
- · Liquid waste-water used for different industries, tanneries, refineries, nuclear energy stations
- Plastic waste-plastic sacks, bottles, container, etc.
- Metal waste-unused metal sheet, metal pieces etc.





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• Atomic waste-unused materials from thermal energy stations

Further we can bunch this multitude of sorts of waste into wet waste (Biodegradable) and dry waste (Non-Biodegradable).

Wet waste (Biodegradable) incorporates the accompanying

- Kitchen Waste including food misuse, everything being equal, cooked and uncooked, including eggshells and bones
- Bloom and natural product Waste including juice strips and house-plant Waste
- Garden clearing or yard Waste comprising of green/dry leaves
- Sterile Wastes
- Green waste from vegetable and natural product sellers/shops
- Waste from food and tea slows down/shops etc.

Dry waste (Non-biodegradable) incorporates the accompanying:

- Paper and plastic, various sorts
- Cardboard and containers
- Compartments of assorted types barring those containing unsafe material
- Bundling, all things considered,
- Glass, all things considered,
- Metals, all things considered,
- Rags, rubber,
- House clearing (dust etc.),
- Ashes,
- Foils, wrappings, pockets, sachets and tetra packs (flushed),
- Disposed of electronic things from workplaces, states viz. tapes, PC diskettes, printer cartridges and electronic parts and
- Disposed of apparel, furniture and equipment's.

Notwithstanding the above Wastes, one more kind of waste called "Domestic Hazardous Waste" may likewise be created at the family level. These incorporate utilized vapour sprayers, batteries, and family kitchen and channel cleaning specialists, vehicle batteries and vehicle care items, corrective things, substance based insect poisons/pesticides, lights, tube-lights and minimal fluorescent lights (CFL), paint, oil, oil and their vacant compartments. Waste that is considered risky is first expected by the EPA to meet the legitimate meaning of strong waste. The EPA integrates dangerous waste into three classes. The primary class are source-explicit Wastes, the subsequent class is vague Wastes, and third, business compound items. For the most part, unsafe waste "will be Waste that is risky or possibly hurtful to our wellbeing or the climate. Dangerous Wastes can be fluids, solids, gases, or ooze. They can be disposed of business items, such as cleaning liquids or pesticides, or the results of assembling processes (EPA Wastes Site, 2010). Correspondingly there is "Non Hazardous waste". There are numerous meanings of perilous and non-dangerous waste inside the US central government, states and industry gatherings. The Department of Defense(DOD) and The Environmental Protection Agency(EPA) characterize Waste as "the extreme, thoughtless, or unnecessary use of DOD reserves or the utilization of DOD property that outcomes from insufficient practices, frameworks, controls, or choices. Moreover, "misuse is how assets or projects are dealt with that makes or propagates waste and it incorporates inappropriate practices not including prosecutable misrepresentation" (EPA Wastes Site, 2010). The Environmental Protection Agency(EPA) characterizes strong non-risky waste as "any trash or decline, slop from a wastewater treatment plant, water supply treatment plant, or air contamination control facility and other disposed of material, including strong, fluid, semi-strong, or contained vaporous material coming about because of modern, business, mining, and farming tasks, and from local area exercises" (EPA Wastes Site, 2010). The meaning of non-unsafe waste can likewise incorporate monetary waste. In 2009 the US official leader request, diminishing Ill-advised Instalments and dispensing with waste in administrative projects was started to take out instalment mistake, waste, extortion and maltreatment in significant Central taxpayer supported initiatives. This





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leader request depends on a straightforward, participatory and cooperative extensive system between the public authority and public.

Management vs. Disposal

There are normal practices to arrange Waste from customary individuals. In any case, removal of waste is turning into a serious and vexing issue for any human residence everywhere. Arranging strong waste far away doesn't tackle the issue however in a roundabout way builds a similar complex and at one point it goes past the control of everyone. The outcomes of this training, for example, wellbeing perils, contamination of soil, water, air and food, horrendous environmental factors, loss of valuable assets that could be acquired from the strong waste, etc. are notable. That is the reason zeroing in on appropriate administration of waste all around the world is fundamental. Waste the executives has turned into a subject of concern internationally and broadly. The Further developed the human settlements, the more mind boggling the waste administration. There is a constant quest for sound answers for this issue yet it is progressively understood that arrangements in light of mechanical advances without human mediation can't support for a really long time and it thusly brings about entangling the issues further. The executives of strong waste which by and large includes legitimate isolation and logical reusing of the relative multitude of parts is truth be told the best approach to managing strong waste. Strong waste administration (SWM) is a normally utilized name and characterized as the utilization of methods to guarantee a deliberate execution of the different elements of assortment, transport, handling, treatment and removal of strong waste (Robinson, 1986). It has created from its initial starting points of simple unloading to a complex scope of choices including re-use, reusing, cremation with energy recuperation, high level landfill plan and designing and a scope of elective innovations. It focuses on a general waste administration framework which is the best ecologically, financially supportable for a specific district and socially OK (World Asset Establishment, 1996; McDougall et al., 2001). This keeps away from the above alluded results as well as it gives financial or money related returns in some or different structures.

Fundamental standards of Solid Waste Management

- 1. 4R's: Reject, Diminish, Reuse and Reuse
- ✓ *Reject*: Purchase nothing which we don't actually require.
- ✓ Decrease Diminish how much trash produced. Change our way of life so least trash is produced.
- ✓ Reuse Reuse all that to its greatest after appropriately cleaning it. Utilize various articles.
- ✓ *Reuse* Keep things which can be reused to be given to cloth pickers or waste pickers (Kabadiwallahs). Convert the recyclable trash into excrements or other helpful items.
- 2. *Segregation at source:* Store natural or biodegradable and inorganic or non-biodegradable strong waste in various canisters. Reuse of the relative multitude of parts with least work and cost.
- 3. **Different treatments for various sorts of solidwastes:** One should apply the strategies which are reasonable to the given kind of trash. For instance, the strategy reasonable for general market waste may not be appropriate for butcher house Waste.
- 4. *Treatment at closest conceivable point:* The strong waste ought to be treated in as decentralized way as could be expected. The trash created ought to be dealt with ideally at the site of age for example each house.

In light of the above standards, an ideal Solid Waste Administration for a village could be as under.

India's Waste Management Framework

Waste the board market contains four portions - Metropolitan Waste, Modern Waste, Bio-Clinical Waste and Electronic Waste Market. This multitude of four kinds of waste are administered by various regulations and approaches just like the idea of the waste. In India Waste the executives practice relies on genuine waste age, essential capacity, essential assortment, optional assortment and transportation, reusing movement, Treatment and removal. In India, region enterprises assume vital part in Waste the executives in every city alongside general wellbeing office. Civil Company is answerable for the administration of the MSW produced in the city, among its different obligations. The general wellbeing division is answerable for sterilization, road purifying, scourge control and food debasement. There is an unmistakable and solid order of posts in the Civil Company. The greatest power of Metropolitan Organization rests with the City chairman, who is chosen for the post for residency of five years. Under





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the Chairman, there is a City Magistrate. Under the city magistrate, there is Top dog who regulates different divisions, for example, general wellbeing, water works, public works, house charge, lights, projection duty, request and a studio, which, thus, all are going by their own specialization heads. The staffs in the General wellbeing division are as per the following: Wellbeing official, Boss clean and food monitor, Sterile and food auditors, Sterile manager, Sweepers, etc. The whole effort of solid waste management (SWM) framework is performed under four headings, to be specific, road purifying, assortment, transportation and removal. The purifying and assortment activities are led by the general wellbeing branch of city Region Partnership, while transportation and removal of waste are done by the transportation division of city District Enterprise. The whole city can be partitioned in to various zones. These zones are additionally partitioned into various sterile wards with the end goal of strong waste assortment and transport tasks. At present waste administration in India generally implies a getting waste from private and modern regions and unloading it at landfill locales. The specialists, typically city, are committed to deal with strong waste produced inside their particular limits; the standard practice observed is of lifting strong waste from the mark of age and pulling too far off places known as unloading grounds or potentially landfill destinations for disposing of. The treatment given to Waste once hence purged is confined to spreading the pile over bigger space to remove the loss from the public look. Waste assortment is normally finished on an agreement premise. In many urban communities it is finished by cloth pickers, modest project workers and districts.

Waste Assortment in India

Basically by the city region

- No gradation of Waste-effect eg bio-degradable, glasses, poly packs, paper shreds etc.
- Dumps these losses to the city edges Nearby raddiwala/kabadiwala (Cloth pickers)
- Gathering little iron pieces by magnets
- Gathering glass bottles
- Gathering paper for reusing/recycling.

In Delhi - MCD-Complex DWM (Delhi Waste The board) vehicle There are various sweepers utilized in road clearing and essential waste assortment in every city. Every sweeper is liable for the day to day purging of a decent region, generally a road including every single side path. Home-grown strong waste is generally tossed on the roads straightforwardly or in plastic sacks from where street sweepers gather it into loads. These waste are then shipped by pushcart streetcar to the close by open dumps or to receptacles, or straight by farm vehicle streetcar to the out-skirt of the urban communities. The street sweepers are furnished with a brush, skillet, favda (spade/showel), wheel barrows, panji (little pointed hand-rake), gayti (guided little spade toward clean street side open depletes) and cans. The loss from road purging is gathered in handcarts and from there on; it is unloaded into side of the road receptacles or at open unloading space alongside family Waste. Metropolitan specialists gather Waste from assortment focuses (open unloading spaces or containers) into different vehicles including farm trucks and bull trucks and take it to removal locales. At times, the labourers gather the MSW from the assortment focuses utilizing chabra (wooden containers) and move it into the vehicles physically. Regularly, bull trucks make only a couple of excursions daily to the last removal site; a farm hauler makes a few outings each day though decline gatherers/unloader placers make four outings. At last reusing and reuse happens by reusing units in various urban communities. Reusing is connected with handling of a waste thing into usable structures.

The idea of reusing and reuse is very much implanted in India to a great extent due to winning financial circumstances and halfway because of conventional practices. In India a few urban communities have turned into a center point for reusing exercises as significant measures of recyclable materials likewise come from connecting towns and towns. Reusing industry principally process paper, plastic, glass and metals. However, reusing isn't an answer for all issues. It's anything but an answer for dealing with each sort of waste material. For some things reusing advancements are inaccessible or perilous. At times, cost of reusing is excessively high. Reusing structures, a major piece of casual area took part in strong waste administration. Waste reusing has, as a matter of fact, both coordinated and sloppy segments. The lower fragments functioning as waste and dump-pickers, vagrant waste





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purchasers, and little merchants go under the sloppy portion, while the large brokers, wholesalers and producers go under the coordinated portion of the waste-reusing area.

Waste Board Drives in India

During the new past, the administration of strong waste has gotten significant consideration from the Focal and State Legislatures and neighbourhood (civil) experts in India. Various associations/collusions are found to exist in the field of strong waste administration in Indian urban communities. These partnerships are public-private, local area public and private courses of action. To distinguish the situation with existing coalitions in the review region, it is first important to recognize the different entertainers working in the field of waste administration.

These entertainers can be gathered as under:

- Public area: this contains nearby power and neighbourhood public divisions at city level;
- *Private-formal area*: this comprises huge and little enrolled ventures doing assortment, transport, treatment, and removal and reusing;
- Private-casual area: this is the limited scale, non-perceived private area and contains Waste pickers, dump-pickers, nomad Waste purchasers, merchants and non-enrolled limited scope undertakings; and Local area agents as NGOs, etc.

These entertainers go into organizations for giving different exercises connected with strong waste administration. These organizations can be as per the following:

- public-private (Neighborhood Authority and confidential endeavors);
- public-localarea (Neighborhood Authority and NGOs); etc
- *private* (Waste pickers, nomad Waste purchasers, Waste merchants and vendors, wholesalers, limited scope and enormous scope reusing undertakings); and
- Public-private-local area (Nearby Power, confidential endeavors and NGOs).

Public Strong Waste Relationship of India (NSWAI) is the main driving proficient non-benefit association in the field of Strong Waste Administration including Harmful and Perilous Waste and furthermore Biomedical Waste in India. It was framed on January 25, 1996. NSWAI helps the Service of Climate and Backwoods (MoEF), New Delhi in different fields of strong waste administration makes strategies and activity designs and is depended the obligation of gathering data and different information connected with strong waste administration from the districts of Metropolitan Class-I cities(population more than 1Lakh) and Metropolitan Class-II cities(population over 50,000), order and disperse the data to site which is connected to public and worldwide associations. The affiliation is an individual from the Worldwide Strong Waste Affiliation (ISWA), Copenhagen, Denmark and gives discussion to trade of data and skill in the field of Strong Waste Administration at the public and global level. The other administrative system for Waste the executives is connected with Indian government Drives for Waste the executives under Jawaharlal Nehru Public Metropolitan Reestablishment Mission (JNNURM), Metropolitan Framework Improvement Plan for Little and Medium Towns (UIDSSMT), "Reused Plastics Production and Utilization Rules (1999) revised and presently known as The Plastics Production and Use (Alteration) Rules (2003), "Draft Rules for Sterilization in Butcher Houses (1998)" by Focal Contamination Control Board (CPCB), Non-biodegradable Trash (Control) Mandate, 2006, Civil Strong Wastes (The board and Taking care of) Rules, 2000, etc.

At the public strategy level, the service of climate and woods has administered the Civil Waste Administration and Dealing with Rules 2000. This regulation subtlety the practices to be trailed by the different districts for overseeing metropolitan waste. Other late strategy archives incorporate the Service of Metropolitan Undertakings' Shukla Advisory Group's Report (January 2000) the High Court delegated Burman Board's Report (Walk 1999), and the Report of the Public Plastic Waste Administration Team (August 1997). To get a feeling of the ongoing status of sterilization in India's urban areas, a review was started by the Service of Metropolitan Improvement as a piece of the Public Rating and Grant Plan for Disinfection in Indian Urban areas. The techniques utilized for the overview can be tracked down on the Service of Metropolitan Advancement site. The Public authority of India declared the Public Metropolitan Disinfection Strategy (NUSP) in 2008. As a piece of this, the public authority proposes to urge states to





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foster their own disinfection methodologies to handle their own sterilization issues and meet the objectives of the NUSP. The rating and grant plot has been taken up under this strategy drive. The primary significant drive was taken by the Decent High Court of India in 1998, which brought about arrangement of a specialist advisory group to concentrate on the situation with SWM in Indian urban areas. This Board recognized the lacks/holes in the current SWM framework in the nation and arranged the Break Report in 1999 on SWM Practices for not many urban areas. As a second significant drive, in conformance with Segments 3, 6 and 25 of the Climate Security Demonstration of 1986, and on the premise on the suggestions by the Board of trustees, the Service of Climate and Timberlands (MoEF) of the Public authority of India, created and gave Metropolitan Strong Waste (The executives and Taking care of) Rules (MoUD, 2000). These principles focus on normalization and requirement of SWM rehearses in metropolitan regions. That's what these standards direct "Every city authority will, inside the regional region of the district, be liable for the execution of the arrangements of these guidelines and framework advancement for assortment, capacity isolation, transportation, handling and removal of metropolitan strong Wastes". The civil specialists are additionally expected to present a point by point yearly report on Waste the board to the Secretary responsible for the Division of Metropolitan Improvement of the concerned State in the event of a metropolitan city; or to the Region Judge or the Representative Chief worried in the event of any remaining towns and urban communities consistently.

According to NSWAI, there are 303 ventures till September 2009 running in the nation connected with Waste the executives, climate and others. The CPCB in a joint effort with Public Ecological Designing Exploration Establishment (NEERI), Nagpur has embraced a definite study of 59 urban communities in the country to evaluate the current status of strong waste administration in these urban areas (MoEF - India). The target of the overview was to survey the consistence status of 59 urban areas with Metropolitan Strong Wastes (The executives and Taking care of) Rules, 2000 and drives taken for further developing strong waste administration rehearses. The 59 urban communities chose for concentrate on cover 35 metro urban communities. It has been seen that drives for assortment of waste from door to door and waste isolation has been attempted in just seven urban communities, privatization of transportation of waste has been finished in 11 urban communities and waste handling offices have been set up in 15 urban communities. Ten waste handling offices depend on fertilizing the soil; one of these treating the soil offices has arrangement for energy recuperation additionally, four depend on vermin-compositing, and one office utilizes pelletisation and energy recuperation innovation. According to medical clinic Waste the Public authority of India (Notice, 1998) determines that Clinic Waste The executives is essential for clinic cleanliness and support exercises. This includes the board of a scope of exercises, which are chiefly designing capabilities, like assortment, transportation, activity/treatment of handling frameworks, and removal of waste. On the off chance that the irresistible part gets blended in with the overall non-irresistible waste, the whole mass turns out to be possibly irresistible. Prior to the notice of Bio-Clinical Strong Waste (The board and Dealing with) Rules 1998, presently changed, Waste from houses, roads, shops, workplaces, enterprises and medical clinics was the obligation of civil or administrative specialists, yet presently it has become compulsory for emergency clinics, facilities, other clinical establishments and veterinary foundations to discard bio-clinical strong waste according to the Law. Other than this large number of drives Delhi Waste The board (DWM) was framed in 2004 as a Particular Reason Vehicle (SPV) in the Public Confidential Organization (PPP) design for assortment, isolation and transportation to landfill destinations of metropolitan waste. More than 1000 representatives are utilized as a piece of this drive. The general drives connected with Waste the board in India can be summarized as continues in the table 1.

Drives taken by Privately owned businesses

There are different privately owned businesses that are giving finished answers for Waste the executives. For instance, Subhash Undertakings and Promoting Restricted (SPML) is a main Designing and Framework improvement association with 26 years in Water, Power and Foundation. Today SPML is flooding ahead in Metropolitan Framework, Strong Waste Administration, Water and Waste Water Frameworks, Crosscountry Pipelines, Ports and SEZs, through BOOT/PPP drives. "SPML Enviro" is a coordinated climate arrangement supplier arm of Subhash Activities and Promoting Restricted (SPML). It gives total arrangement corresponding to assortment, transportation and removal of civil/dangerous waste, isolation and reusing of metropolitan waste, development and the executives of clean landfill, development and activity of manure plant and waste to energy plant at the Delhi air





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terminal and Hyderabad Air terminal. SPML Enviro has put resources into the fundamental assets and organizations to give strong and water treatment arrangements. It skill incorporates strong waste-to-assets' answers - general, modern and clinical waste. SPML Enviro has collaborated with PEAT Global, North Illinois, USA, a waste-to-assets organization gaining practical experience in treating and changing waste over completely to usable assets. PEAT's exclusive Plasma Warm Obliteration Recuperation (PTDR) innovation is a harmless to the ecosystem interaction, that converts Wastes into non-poisonous manufactured gas (which is an important wellspring of elective energy) and other valuable final results. The PTDR is a demonstrated, savvy, naturally spotless and economically practical answer for Waste remediation. SPML Enviro along with its joint-adventure accomplices, has demonstrated capacities to effectively execute projects on turn-key premise including Okhla sewage treatment plant, Delhi Jal Board, Bewana normal profluent treatment, Delhi State Modern Improvement Partnership, Delhi State Modern Advancement Enterprise, Yelahanka essential/tertiary sewage treatment plant, Bangalore Water Supply and Sewerage Board, Okhla normal gushing treatment plant, Sewage treatment plant, Mysore, Karnataka water supply and sewerage board, etc. SPML has likewise framed a joint endeavour with the US based Company INSITUFORM Technologies(INC.). INSITUFORM is a pioneer in sewer rehabilitation projects worldwide. The Company brings with them a No Dig Technology, that eliminates replacement of old sewers. In this, pipe within a pipe concept - a liner is inserted into these were, which makes it as good as new.

Drives taken by Indian corporate

In India, there are different drives taken by numerous companies. For instance, HCL Data framework accepts that the makers of electronic merchandise are liable for working with a removal that welcomes naturals, when the item has arrived at the finish of its life. HCL Data framework upholds the continuous drive for isolated e-Waste regulation in India. HCL has been dealing with a simple, advantageous and safe program for reusing of e-Waste in India. HCL has made the web-based course of e-Waste reusing demand enrollment, where clients (both individual and corporate) can enroll their solicitations for removal of their e-Waste. Aside from corporate clients, HCL has broadened its e-Waste assortment program to retail clients additionally through its HCL Contact spread focuses spread the nation over HCL stretches out the reusing office to its clients no matter what the reality, when and where they bought the item. To advance reusing of electronic waste, Nokia India sent off a 'Reclaim' crusade where clients can drop their old handset in the organization's stores and win gifts. The reclaim crusade is pointed toward instructing cell phone clients on the significance of reusing e-Waste. As a piece of this drive, Nokia urge cell phone clients to arrange their pre-owned handsets and frill like charges and handsets, no matter what the brand, at any of the reusing containers put forth up across Nokia Boundary Vendors and Nokia Care Focuses. ITC Ltd has picked energy the executives, ecological and Waste the board and social and ranch ranger service as significant center regions for CSR. Explicit cycles incorporate reusing/reuse of paper factory back water for weakening of blanched mash, reusing of paper machine essential clarifier outlet water for random purposes, etc. These are not many guides to show that Indian corporate isn't behind in creating drives connected with Waste the board.

Challenges in India

Central questions and difficulties incorporate absence of assortment and isolation at source, shortage of land, unloading of e-Waste, absence of mindfulness, etc. Basic unloading of blended Waste is the training followed essentially all over the place and particularly in the non-industrial nations as they can't prepare monetary assets for applying costly innovation propounded by the created nations. In India, "The new Metropolitan Strong Waste Administration Rules 2000", which became effective from January 2004, come up short, even to oversee Waste in a cyclic interaction. Waste the board actually is a direct arrangement of assortment and removal, making wellbeing and ecological perils. Metropolitan India is probably going to confront an enormous garbage removal issue before very long. As of recently, the issue of waste has been viewed as one of cleaning and arranging as garbage. In any case, a more critical glance at the current and future situation uncovers that waste should be dealt with comprehensively, perceiving its normal asset roots as well as wellbeing influences. Waste can be riches, which has colossal potential not just for producing jobs for the metropolitan poor yet can likewise advance the earth through treating the soil and reusing as opposed to spreading contamination as has been the situation. Expanding metropolitan relocation and a high thickness of populace will make Waste the executives a troublesome issue to deal with sooner rather than later,





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on the off chance that another worldview for moving toward it isn't made. A solid need felt on confidential area support in Waste the executives yet we cannot overlook the gamble of private area cooperation. Dangers of private area contribution might incorporate an absence of straightforwardness, a business disappointment that would then prompt unsettling influence of public administrations, or low collaboration between partners. Another significant inquiry is that how powerful are the public-private organizations? We recollect that Chennai based company and French aggregate Onyx banded together for trash assortment. Yet, we truly don't have any idea how successful it was in common sense. The Company paid weighty sum for trash leeway. However, there were grievances against the organization. Regardless the organization was essentially gathering trash and unloading it on the dumpsites. There is no designing supernatural occurrence in gathering and unloading waste. The way forward is legitimate waste administration strategies which should be taken on and obligations of each are characterized in appropriate way and accurately watched, assuming that the metropolitan specialists get the privately owned businesses (like onyx) to fertilizing the soil and reusing Wastes as opposed to simply unloading it. There has been an assortment of strategy reactions to the issue of metropolitan strong waste in India, particularly throughout recent years, at this point economical arrangements both of natural or inorganic waste remaining parts undiscovered and unattended. For agricultural nations, reusing of waste is the most monetarily practical choice accessible both regarding work age for the metropolitan poor without any abilities and speculation. All strategy records as well as regulation managing metropolitan strong waste notice or recognize reusing as one of the approaches to redirecting waste, yet they do as such in a piece-dinner way and don't address the system expected to empower this to occur.

Basic issues, for example, industry obligation, a basic worldview to empower feasible reusing and to catalyze Waste decrease through, say better pressing, have not been addressed. Reusing of just a few sorts of materials like plastics, paper and metals isn't sufficient. Many kinds of new materials basically utilized for bundling are not, or without a doubt can't be, reused in the low-end innovation being utilized. Additionally, there are difficult issues of poor word related security arrangements of the waste pickers as well as labourers. In India, new and costly advances are being pushed to manage our metropolitan waste issue, disregarding their ecological and social ramifications. It is especially obvious on account of warm treatment of waste utilizing innovations like gasification, burning, pyrolysis or pellatisation. Indian waste substance doesn't give sufficient fuel esteem (caloric incentive) for beneficial energy creation. It needs the expansion of assistant fuel or energy. Such advancements put networks to risk and are gone against generally. For instance, the US has not had the option to introduce another incinerator for the beyond five years, while costs for consuming trash have raised cosmically with rising ecological norms in different nations. While the more evolved nations are getting rid of incinerators due to significant expenses (because of better expectations of outflow control), emerging nations have become likely business sectors for unloading such advances.

Ideas for future improvement

The political will is the main goal. By and large Government bodies and regions give need to introduce issues which they face however don't think for future issues because of natural rot. That's what their view is, they will tackle issues when they will confront it yet not presently. Since working on something for climate doesn't give political gains or guarantee next time seat. Presently questions are that how might we change this mind-set? We accept there ought to be a positive methodology for quite a while arranging and execution. Regulation and its powerful implementation is a key to manageability for which the structure expects to be laid out. Endeavours to work on Waste capacity and assortment are required. This should be possible when every family and territory are given standard canisters that are set outside for simplicity of assortment. In regions where this isn't suitable, halfway found Waste assortment focuses ought to be laid out that are shared by various families. Wastes need to be progressively arranged at the source, to isolate materials that can be reused and to elicit how much Wastes requiring assortment and removal. Coactivity is expected among networks, the casual area, the proper waste gatherers and the specialists. A powerful Strong Waste Administration framework ought to target limiting manual dealing with and 100 % assortment and transportation of strong Wastes ought to be accomplished. In strong waste administration, one thing turned out to be extremely evident that isolation at source is to be drilled. There are heaps of drives to oversee Wastes however goes in vein as a result of not recognizing abundance in Wastes. In India, we can't bear the cost of clean land filling as land is valuable to a great extent are part of regions who don't have land as digging ground. The source isolation needs





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parcel of concentrate on human way of behaving against Waste littering. A nonstop sharpening program is to be arranged by the opinions of the occupants towards their city and at last it will fill in as marvels. In the event that Waste isolation is drilled, the potential dangers can be limited straightforwardly. In addition, the nature of materials recovered will be better because of nonattendance of blending. The pickers can accordingly, bring better cash on the materials recovered other than having lesser dangers of getting sicknesses, cuts and wounds experienced in the standard act of waste picking. The reception and move of the advances from the created nations without adjusting them to the nearby or territorial point of view would be misleading with respect to the agricultural nations. Thusly, the specialized perspectives for a waste administration would need to consider many focuses for arranging and execution of systems as indicated by circumstance of the country. It would require the reinforcing of the administration area which needs to remain inseparable with specialized arranging. Overall population can assume a vital part. Public investment is fundamental for a legitimate waste administration framework. Works on in the propensities for isolation, littering, can change the methodology towards Wastes. For instance, in a legacy town of West Bengal, there was a development connected with Waste the board. Inside a range of two years it effectively sharpened occupants for isolation at source and not littering in open regions. Presently the city is truly turning out to be perfect and others are likewise taking part in the development. To further develop the framework proficiency and increment the inclusion to 100% in every city, investigating elective game plans for assortment of waste like including private operators is suggested. A component to create income from the residents ought to likewise be created. Nonetheless, the way to deal with public-private associations sought after in the created nations can't be recreated for Indian towns overall. This approach must be executed after certain changes considering the neighbourhood conditions. There might be discrete equal decentralized plans by the public authority.

Monetary help by the local area in view of decentralized plans will give the right driving force to the improvement of waste administration strategy. For instance, the region of Bangalore has an equal plan, "Swaccha Bangalore", which demands compulsory charges for all families, organizations and instructive foundations to build its monetary assets. These client expenses infer that the inhabitants will anticipate that the region should give appropriate waste assortment administrations. It coordinates them into the general waste administration procedure in all territories accordingly assisting with diminishing how much Wastes going external the region. The imposing of waste assortment and removal charges ought to be founded on Waste age rates and as indicated by the monetary norm of the area, while thinking about the idea of the waste any place vital. In any case, these charges ought not be required exclusively to meet the monetary lacunae for the board and the hardware interest. In India Waste the board could emerge provided that help conveyance will be connected to private area cooperation. "The fact that the confidential makes it fundamental area approaches and empowers the public area partners to devise proper systems that outcome in a mutual benefit for the two sides." Despite the fact that there are a few drives taken by corporate however there is solid requirements that all corporate should approach to venture out. Essentially they ought to deal with their modern waste rather littering and tossing in the streams as we can find numerous models in Indian urban communities like Kanpur, Varanasi, Agra, etc. The confidential area could likewise assume a significant part in building the limits of metropolitan bodies. Strong waste administration, alongside reusing, presents a lot of chances for organizations. For instance, EXNORA is a NGO in Chennai that spotlights on the climate through their strong waste administration program, which works in districts all through Tamil Nadu.

As a matter of fact, in spite of the absence of legitimate lawful and monetary help by open organizations, the casual area has a firm standing and gives a priceless support of a huge segment of the general public corresponding to Waste the executives. There is a pressing need to comprehend the essential job of this casual area participated in civil strong waste administration, study their financial circumstances, and to coordinate them with the proper area to accomplish feasible strong waste administration on one hand and work on their everyday environments on the other. The conceivable future strategy choices accessible with the arrangement producers for the executives of metropolitan strong waste are to advance either/each of the current coalitions between private undertakings, private-public endeavours and private-public-local area. The chose situation ought to be founded on financial, natural and wellbeing contemplations. It ought to satisfy the essential objective of reusing the most extreme waste produced, making greatest work through cleaner strategies without bringing any danger/diminishing the potential wellbeing





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risks to the lower rung of the waste reusing area and working on their financial circumstances, too. Another choice is to advance arrangement of miniature endeavours among the waste-reusing area through different strategies. It is seen from different contextual analyses of agricultural nations like Latin America, Egypt, etc. that assuming waste pickers and recyclers gain official appreciation from the nearby specialists and they coordinate themselves and standardize their exercises, there is a general improvement in the day to day environments of these individuals. Miniature ventures in the field of strong waste administration area are another cycle in India and just couple of models are accessible. The Independently Employed Ladies' Affiliation (SEWA), Ahmedabad, India effectively worked on the everyday environments of lady's paper pickers, by coordinating them into cooperatives and via looking for effectively available unrefined components in mass amount. There are a few missing connections and many remaining details both regarding the executives, innovation and expert expertise. The arrangements need careful comprehension, for instance, sending of capable people qualified in strong waste administration (genuine hard slave drivers and not individuals who turn up with a hanky to cover their nose to fend the smell off), utilization of productive blend of waste taking care of supplies in savvy way and smoothing out of the treatment of waste at different stages all through its excursion from wellspring of age to extreme safe removal site, without transitional unloading and gathering of waste for quite a long time together. A perfect nonstop stream sheet of waste administration must be created. Matching monetary help, discipline and attitudinal change in completely concerned will clearly be the key for powerful and fruitful waste administration in India.

In India the landfill, once in a while depicted as 'sterile landfill', doesn't go past topping off of low-lying regions with smelling waste helpfully bypassing the suggested prerequisites for 'clean landfill'. Eventually, whatever is exhausted at unloading or landfill locales keeps on causing serious natural theft. The created nations really do flaunt that they handle their loss in a more logical way at landfill locales by laying the unloading grounds with a vulcanized plastic sheet to try not to filter of poisonous processed and undigested waste into the ground under. In our nations specialists rehearsing landfill really do pronounce that they steadily carry out prerequisites for prescribed landfill to mollify resident concern. The quantum of strong waste is truly expanding because of many reasons. Plastics Waste is a huge part of the all-out metropolitan strong waste (MSW). Reusing of plastics ought to be conveyed in such a way to limit the contamination level during the cycle and thus to upgrade the productivity of the interaction and monitor the energy. More up to date procedures connected with reusing and reuse of plastic can be embraced.

Any new worldview ought to incorporate a support to-grave methodology with obligation being shared by numerous partners, including item makers, buyers, networks, the reusing business, exchange, districts and the metropolitan poor. The Service of Metropolitan Turn of events and Neediness Lightening, as well as Agribusiness, ought to foster the market for fertilizer, and whenever required give sponsorships to compost excrement - first to give natural soil supplements to the ranchers and to tackle the metropolitan waste issue which persistently is dirtying land through uncontrolled unloading. To cause legitimate waste administration movement to support in evident sense, following different focuses should be concentrated on -

- 1. Region explicit preparation: Taking a gander at the geological, geographical and social variety of the country it very well may be isolated into five districts, for example, Northern area, Eastern district, Western locale, Focal area and Southern district. Every one of these areas has different design. Thus every one of the exercises ought to be arranged and executed on provincial premise.
- 2. Planning from underneath: To make Strong Waste Administration an outcome in obvious sense, the preparation as well as execution ought to begin from overall population level arranging followed by block level preparation, locale level preparation and state level preparation.
- 3. Involvement of self-improvement gatherings, youth gatherings and little business people: The overall population level waste administration units can be controlled by self-improvement gatherings, youth gatherings or little business visionaries. This will help in making the program self-strong and manageable.
- 4. Well-arranged and powerful preparation strategy: Specialized preparing at all levels (Overall population to state) shapes the foundation of an effective waste administration program. Satisfactory preparation should be given to every one of those worried preceding genuine sending off of the program in the field.





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CONCLUSION

It is doing the trick to say that we require a more severe incorporated and vital waste counteraction structure to really address wastage related issues. There is a critical need to expand after existing frameworks as opposed to endeavouring to supplant them aimlessly with models from created nations. To forestall any pestilence and to make every city a solid city-monetarily and earth, there is a dire requirement for an obvious key waste administration plan and a solid execution of similar in India. To accomplish monetary maintainability, financial and natural objectives in the field of waste administration, there is a need to methodically break down the qualities and shortcomings of the local area as well as the civil company, in view of which a successful waste administration framework can be developed with the support of different partners in India. The public detachment can be changed by mindfulness building efforts and instructive measures. Sharpening of the local area is likewise fundamental to accomplish the above goals and we really want to endlessly move quickly as each city in India is now a hotbed of numerous infectious illnesses, the majority of which are brought about by inadequate waste administration. This multitude of above said ideas are given corresponding to India and will be powerful just when we exclusively feel the obligation of making climate clean. As overall population, we cannot do a lot of in strategy and guidelines definition, reception of more current innovations connected with reusing and other waste administration choices however we can assume a vital part in this cycle in the event that we can take on just couple of tips. The following are a couple of tips to accomplish this objective.

- 1. **Keep our self-informed:** It is critical that we are in the loop about what's going on the climate front. Find out about how untreated sewage is tossed into the streams, go to public talks about air contamination, and stay in contact with new strategies that influence our current circumstance. The more educated we are, the better prepared we are to battle such issues.
- 2. **Consume less:** Aphorism: Decline..., Diminish.... Reuse... Reuse. This implies consuming less assets, reusing anything we can lastly reusing what can't be reused. This interaction enormously decreases the trash.
- 3. **Say 'No' to plastic packs:** One of the greatest wellsprings of contamination in Indian urban communities is the omnipresent plastic sack. Decline to acknowledge one. All things being equal, convey a fabric shopping pack with us
- 4. **Separate our trash:** India has one of the world's most productive reusing systems. Utilize the assistance of our raddiwalla. Papers, bottle jars and other such recyclables can bring us cash and in the process we can assist with saving the climate. Cloth pickers, as well, carry out an essential role for the city. Kitchen trash (biodegradable) ought to be isolated from non-biodegradable waste.
- 5. **Compost our natural waste**: Begin a vermiculture receptacle. We can persuade our neighbours to begin a vermiculture receptacle likewise to deliver excrement.
- 6. **Stop consuming trash:** Request that our neighbours stop from consuming strong Wastes. It might appear to be innocuous yet smoke radiated from leaves adds to air contamination. Likewise, when there is plastic in the store, it discharges perilous harmful vapour. Leaves can be switched over completely to manure through treating the soil and plastic can be reused.

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Table 1.India's Waste Management Initiatives

Policy and Regulation				
	Central Level			
Institutional Framework	State Level			
	Other Organizations/Associations			
	• 74thConstitutional Amendment Act, 1992			
	Management and Handling Rules			
	Environment (Protection) Act, 1986			
Legal Framework	National Environment Tribunal Act, 1995			
	National Environment Appellate Authority Act, 1997			
	Water (Prevention & Control of Pollution) Act, 1974			
	Water (Prevention & Control of Pollution) Cess Act, 1977			
English and a Lal Nie man	Existing Environmental Standards			
Environmental Norms	Recently Notified Environmental Standards			
	National Urban Sanitation Policy, 2008			
	National Environment Policy, 2006			
	Policy Statement for Abatement of Pollution, 1992			
Policy Initiatives	National Conservation Strategy and Policy Statement on			
	Environment and Development, 1992			
	Law Commission Recommendation			
	• Eco mark Scheme, 1991			
Key Government				
Programmes				
JNNURM	Programme Scope and Structure			
JININUINI	Funding			

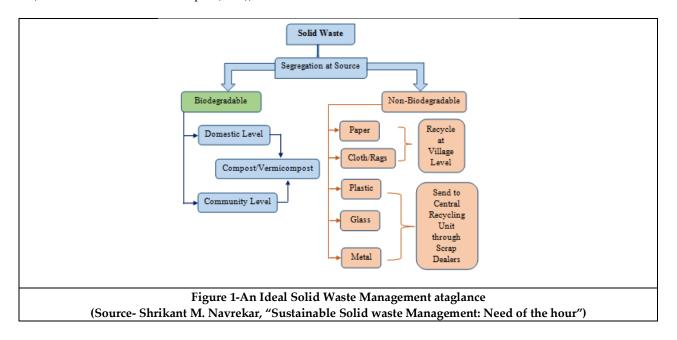




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	Experience So Far			
	Experience on Reforms			
	Issues and Challenges			
	Programme Scope and Structure			
Talal Caritatian Cananian	• Funding			
Total Sanitation Campaign	Experience So Far			
	Issues and Challenges			
MAIDEL IAZ A A E	Programme Scope and Structure			
MNRE's Waste-to-Energy	Experience So Far			
Programmes	Issues and Challenges			
	Integrated Low Cost Sanitation Scheme			
Other Programmes	National Biogas and Manure Management			
	Programme			
Technology and Practices				
Traditional Technologies	• Landfills			
Rural Waste Management	Waste Incineration			
Industrial Solid Waste	Sanitation			
Mgt.	Municipal Liquid Waste Projects			
Liquid Wasta Managamant	Industrial Liquid Waste			
Liquid Waste Management	Other Noteworthy Water Reuse and Recycling			

(Source-India Infrastructure report(2009))







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RESEARCH ARTICLE

Phytochemical Profiling and Mosquito Larvicidal Potential of Selected Pteridophytes of Kerala, India

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ABSTRACT

Mosquitoes are a commonly occurring group of insects, treated as harmful being the primary source of disease transmission. In order to stop epidemics and safeguard public health, mosquito eradication measures are essential. It is important to think before applying chemical pesticides, because long-term pesticide use can harm the ecosystem. Biological products can be used in this scenario to target the larvae of mosquitoes and to eradicate them. The present study aims to elucidate the larvicidal potential of some selected Pteridophytes of Kerala. For this, aqueous extracts of 15 plants were tested, of which 8 plants showing more than 50% larvicidal efficacy were chosen for methanol extract analysis. Among the different methanol extracts of plants, Pteris vittata L. showed lowest LC50 value of 145.34 ppm and LC 90 value of 835 ppm exhibiting significant larvicidal activity. Preliminary phytochemical screening of these plants revealed the presence of alkaloids, steroids, triterpenoids, cardiac glycosides in almost all plants. We can infer that the presence of these bioactive compounds attributes to its larvicidal activity and can make use of these underutilized plants for mosquito eradication. The work is an inventory revealing the larvicidal activity of some commonly available Pteridophytes of Kerala.

Keywords: Larvicidal activity, Pteridophytes, LC50 value, LC90 value





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INTRODUCTION

Inadequate disposal of waste brought on by urbanization and present lifestyle stimulates the growth of mosquito population and accelerates the transmission of diseases. Mosquitoes are insects that belong to the Diptera order of flies. "Two wings," or diptera, is the feature that sets these flies apart from other insect species (long tubular mouth parts for sucking up blood fluids and hair-like scales in their body). Culex mosquitoes are involved in the transmission of human diseases like Filaria and Japanese Encephalitis. These mosquitoes are hardy and are able to survive extreme conditions. Culex quinquefasciatus is the most common mosquito species, a vector of Wuchereria bancrofti, an urban vector, which causes filarial fever and is primarily found in tropical areas, with 44 million people having a common chronic look and roughly 120 million persons affected globally [1]. Mosquito eradication is essential to controlling the spread of numerous diseases. To lower the threat of diseases transmitted through mosquitoes, regular monitoring of breeding locations, use of pesticides and other measures are typically employed. Targeting larvae with organophosphate and insect growth regulators is now adopted to control mosquitoes. But these may lead to disappearance of many useful organisms and may bring harmful effects in future[2]. Although chemicals can be used to control insects, upon continuous usage of which it is possible for the insects to develop a resistance to the chemicals and grow stronger. The biological activity of plant extracts might be due to various compounds, including phenolics, terpenoids, and alkaloids present in plants[3]. Preliminary phytochemical screening of plants reveals the wide array of phytochemicals, using the bioactivity of phytochemicals, plants can be utilized to eliminate these mosquito vectors. Plant extracts have generally been acknowledged as a significant natural source for the management of parasites and pests that affect public health [4]. Plant derived insecticides are having low cost, easy availability, biodegradability and organic nature of the compounds have extremely little likelihood of causing adverse effects and very little chance of causing pests to become resistant to them. Pteridophytes are the first vascular plants to become prominent during the Carboniferous Period. Many of its species have long been used in ethnomedicine. Despite the fact that there hasn't been much research done on the larvicidal potential of many plants, the present study is an attempt to find out the effectiveness of some commonly available Pteridophytes in mosquito larvicidal activity.

MATERIALS AND METHODS

Collection of Plant Material

Fresh, mature and green fronds of fifteen commonly available Pteridophytes were collected from different locations of Kerala, India (Table 1). The selection of plants was carried out based on their local availability and available literature. The taxonomic identity of the plants was determined and the voucher specimen was deposited at the Government Victoria College Herbarium (GVCH).

Preparation of fresh plant extracts

The plant materials were cleaned, allowed to air dry and stored in troughs that were kept clean. About 2g of plant materials were prepared for the extracts by crushing them using a mortar and pestle in distilled water. The extract was filtered and the resulting filtrate was added to 100 millilitres of distilled water to preserve it as a stock solution for additional testing. Plants exhibiting greater than 50% mortality were chosen for the methanol extraction based on their mortality rate at 2% solution.

Preparation of methanol extract of plants

For methanol extraction, plants with high larvicidal efficacy in fresh extracts were chosen. These plants were dried and ground into fine powder. In a shaking incubator, 10 grams of powdered plant material was extracted with 100 ml of methanol over a duration of 24 hours. Using Whatman No. 1 filter paper, the extract was filtered followed by complete evaporation of the solvent. The concentrated extracts were then refrigerated until needed and stored in closed amber-colored glass bottles. To create a homogenous stock solution for the experimental treatment, 1 mg of





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each extract was diluted in 1 ml of dimethyl sulfoxide (DMSO). A serial solution with distilled water was used to generate a graded series of test solutions with varying concentrations (80 ppm–12000 ppm) from the stock solution.

Mosquito Larvicidal Bioassays

For all bioassays, the standard protocols were adhered completely[5]. After supplying ambient room temperature and moisture content, larval colonies were reared in plastic trays and given a diet of decomposing leaves and yeast granules. For the purpose of the study, early fourth instar larvae were selected. Different concentrations of fresh extract, methanol extract and controls were evaluated on ten larvae each. For comparison, two control tests were simultaneously set up, one with distilled water only and the other with distilled water plus dimethyl sulfoxide (DMSO). For each concentration, three duplicates were created. After being exposed for 24 hours, the larvae were observed for their mortality and survival rates were noted. The average of three replicates was used to determine the larvae's mortality rate. Toxicity was reported as LC50 and LC90 values, representing the concentrations in ppm with 50% and 90% larval mortality rates in 24 hours, respectively.

Statistical Analysis

T-tests and larval mortality mean standard deviations were computed. A significance level of P<0.05 was applied. To get the LC $_{50}$ and LC $_{90}$ values, the mortality data were examined using probit analysis[6]. The statistical studies were executed with Microsoft Excel software.

Preliminary phytochemical screening

Plants with greater larvicidal activity in methanol extracts were chosen for the preliminary qualitative phytochemical screening to identify the phytoconstituents causing the larvicidal activity. Standard procedures were followed to undertake various phytochemical analysis of the plant extracts[7,8,9].

RESULTS

Larvicidal activity of fresh extracts of plants

The larvicidal activity of aqueous extracts of 15 plants were tested (Table 2) at 2% concentration. Plants which showed more than 50% larvicidal activity, were selected for methanol extract analysis which includes *Adiantum incisum*, *Adiantum latifolium*, *Diplazium brachylobum*, *Diplazium esculentum*, *Lygodium flexuosum*, *Pityrogramma calomelanos*, *Pteris praetermissa* and *Pteris vittata*. Among the different plants, extracts of *Adiantum incisum*, *Diplazium esculentum* and *Pteris vittata* exhibited maximum larvicidal activity.

Larvicidal activity of methanol extracts of plants

Methanol extract of eight plants tested showed significant larvicidal activity. The mean and standard deviation of larval mortality were calculated using Microsoft Excel (Table 3). The LC50 and LC90 values of these eight plants were calculated (Table 4; Figure 1) and lower the LC50 and LC90 values signifies higher larvicidal activity. We can therefore arrange plants in the order of their larvicidal activity based on these LC50 and LC90 values as, *Pteris vittata>Diplazium esculentum >Adiantum incisum>Diplazium brachylobum >Adiantum latifolium>Pityrogramma calomelanos>Lygodium flexuosum>Pteris praetermissa*. Based on these observations, we can conclude that *Pteris vittata*, *Diplazium esculentum*, *Adiantum incisum* and *Diplazium brachylobum* showed significant larvicidal activity in both fresh and methanol extracts. Among the different plants, *Pteris vittata* is a potential candidate for larvicidal bioassays having LC50 and LC90 values of 145.34 ppm and 835 ppm respectively.

Preliminary Phytochemical screening

The reason behind the pharmacological potential is the presence of a wide array of phytochemicals in them. To elucidate the bioactive active components, preliminary phytochemical screening was done in eight plants having larvicidal activity in their methanol extract. From the study, it was clear that compounds such as steroids and alkaloids were present in methanol extracts of all the plants. The results are summarized in Table 5.





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DISCUSSION

Numerous techniques are used to eradicate mosquitoes since they constitute a major threat as disease vectors. Since a long time ago, a lot of insecticides have been employed, which has led to increased mosquito resistance as well as detrimental effects on non-target creatures. Culex quinquefasciatus has high resistance to deltamethrin, moderate resistance to malathion and is slightly resistant to temephos[10]. The present study aims to showcase the method for eradicating mosquito larvae by taking advantage of the pharmacological potential of some selected Pteridophytes. The phytochemical screening tested positive for various bioactive components which may be responsible for their larvicidal actions. Phytochemicals such as alkaloids, saponins, tannins, flavonoids and steroids are effective against Culex quinquefasciatus, Aedes aegypti and Anopheles stephensi[11]. Of the various primary and secondary metabolites of ferns, phyto-ecdysone is a special secondary metabolite produced by ferns and affects a wide range of insects at very low concentrations[12]. Even though the studies are limited in this plant group, the current study demonstrated the larvicidal potential of locally available Pteridophytes of Kerala and this work can be extended to identify and isolate the bioactive components for future purposes of mosquito eradication. The primary objective of the current study was to demonstrate a potential strategy for eliminating mosquitoes by making use of an underutilized plant group. The study evaluated a few Pteridophytes that were available locally for their larvicidal properties. More investigation into the biological function of these plants is anticipated in order to create the novel natural pesticides. Such research works can pay greater attention to the usage of biopesticides to a healthier lifestyle and safe environment.

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Table. 1 List of Plants Selected for Mosquito Larvicidal Activity

Sl. No.	Name of the plant	Family	Plant part used
1	Adiantum incisum Forssk.	Pteridaceae	Whole plant
2	Adiantum latifolium Lam.	Pteridaceae	Whole plant
3	Adiantum philippense L.	Pteridaceae	Whole plant
4	Christella dentata Forssk.	Thelypteridaceae	Fronds
5	Cyclosorus interruptus Wild.	Thelypteridaceae	Fronds
6	Diplazium brachylobum (Sledge) Manickam & Irudayaraj	Athyriaceae	Whole plant
7	Diplazium esculentum (Retz.) Sw.	Athyriaceae	Whole plant
8	Lygodium flexuosum (L.)Sw.	Lygodiaceae	Fronds
9	Marsilea minuta L.	Marsileaceae	Whole plant
10	Mickelopteris cordata (Roxb.ex Hook.& Grev.) Fraser-Jenk	Pteridaceae	Fronds
11	Nephrolepis cordifolia (L.) C. Presl	Nephrolepidaceae	Fronds
12	Pityrogramma calomelanos (L.) Link	Pteridaceae	Fronds
13	Pteris praetermissa T.G.Walker	Pteridaceae	Fronds
14	Pteris vittata L.	Pteridaceae	Fronds
15	Selaginella delicatula (Desv.)Alston	Selaginellaceae	Whole plant

Table 2 Larvicidal Activity of Aqueous Plant Extracts

Sl. No.	Name of the mlant	Mortality rate (%)		
51. No.	Name of the plant	1%	2%	
1	Adiantum incisum Forssk.	60	90	
2	Adiantum latifolium Lam.	40	70	
3	Adiantum philippense L.	20	30	
4	Christella dentata Forssk.	20	30	
5	Cyclosorus interruptus (Wild.)	10	40	
6	Diplazium brachylobum (Sledge) Manickam & Irudayaraj	60	80	
7	Diplazium esculentum (Retz.) Sw.	70	90	
8	Lygodium flexuosum (L.)Sw.	40	60	
9	Marselia minuta L.	30	40	
10	Mickelopteris cordata (Roxb.ex Hook.& Grev.) Fraser-Jenk	0	0	
11	Nephrolepis cordifolia (L.) C. Presl	0	30	
12	Pityrogramma calomelanos (L.) Link	60	70	
13	Pteris praetermissa T.G.Walker	50	50	
14	Pteris vittata L.	70	100	
15	Selaginella delicatula (Desv.)Alston	0	10	





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Table 3: Mosquito Larvicidal Activity of Methanol Extracts of Plants

		Ĭ		PLANT	NAMES			
Concentration (ppm)	Adiantum incisum	Adiantum Iatifolium	Diplazium esculentum	Diplaziun brachylobum	Lygodium flexuosum	Pityrogramm a calomelanos	Pteris praeternissa	Pteris vittata
80(0.008%)	0	0	0	0	0	0	0	33.3±0.58
100(0.01%)	0	0	0	0	0	0	0	46.6±0
200(0.02)%	6.7±0.58	0	13.3±0.58	0	0	6.7±0.58	0	60±0
400(0.04%)	16.7±0.58	6.7±0.58	23.3±0.58	16.6±0.58	0	16.7±0.58	0	76±0
600(0.06%)	26.7±0.58	16.7±0.58	26.6±0.58	23.3±0.58	0	23.3±0.58	0	80±1
800(0.08%)	33.3±0.58	23.3±0.58	36.6±0.58	26.6±0.58	0	26.7±0.58	0	83.3±0.58
1000(0.1%)	43.3±0.58	26.7±0.58	46.6±0.58	33.3±0.58	6.7±0.58	30±1	0	96.7±0.58
1200(0.12%)	53.3±0.58	36.7±0.58	53.3±0.58	40±0.58	16.7±0.58	36.6±0.58	0	100±0
1400(0.14%)	56.7±0.58	46.7±0.58	63.3±0.58	46.6±0.58	23.3±0.58	40±0	13.3±0.58	100±0
1600(0.16%)	66.7±0.58	56.7±0.58	73.3±0.58	56.6±0.58	33.3±0.58	46.7±0.58	26.7±0.58	100±0
1800(0.18%)	83.3±0.58	66.7±0.58	80±0.58	60±0.58	46.7±0.58	53.3±0.58	36.7±0.58	100±0
2000(0.2%)	93.3±0.58	73.3±0.58	86.6±0.58	73.3±0.58	56.7±0.58	63.3±0.58	43.3±0.58	100±0
4000(0.4%)	100±0	76.7±0.58	100±0	86.6±0.58	66.7±0.58	83.3±0.58	53.3±0.58	100±0
6000(0.6%)	100±0	83.3±0.58	100±0	100±0	83.3±0.58	100±0	63.3±0.58	100±0
8000(0.8%)	100±0	86.7±0.58	100±0	100±0	100±0	100±0	76.7±0.58	100±0
10000(1%)	100±0	100±0	100±0	100±0	100±0	100±0	93.3±0.58	100±0
12000(1.2)%	100±0	100±0	100±0	100±0	100±0	100±0	100±0	100±0

Table 4: LC50 AND LC90 Values of Methanol Extracts of Plants

Sl. No.	Plant Names	LC ₅₀ (ppm)	LC90 (ppm)
1	Adiantum incisum	1160.63	2136.29
2	Adiantum latifolium	1522.87	2548.51
3	Diplazium brachylobum	1482.15	2732.15
4	Diplazium esculentum	1104.53	2080.14
5	Lygodium flexuosum	1924	2775.95
6	Pityrogramma calomelanos	1751.19	3289.65
7	Pteris praetermissa	3737.09	7373.45
8	Pteris vittata	145.34	835



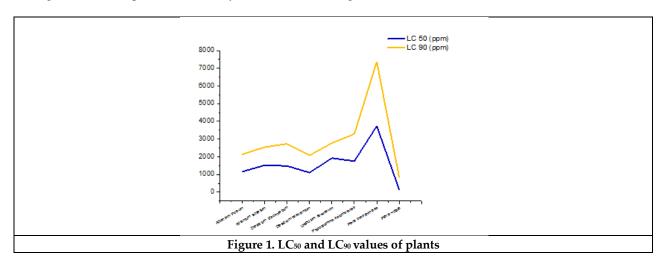


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Table 5: Phytochemical Screening of Plant Extracts

Sl. No	Phytochemicals	Adiantum incisum	Adiantumlatifo lium	Diplazium brachylobum	Diplazium esculentum	Lygodium flexuosum	Pteris praetermissa	Pteris vittata	Pityrogramma calomelanos
1	Alkaloids	+	+	+	+	+	+	+	+
2	Tannins and Phenols	+	-	+	+	+	+	-	+
3	Steroids and Terpenoids	+	+	+	+	+	+	+	+
4	Flavonoids	+	+	-	+	+	+	+	+
5	Coumarins	+	+	+	+	-	-	-	-
6	Cardiac glycosides	+	+	-	-	+	+	+	+
7	Saponins	+	-	-	+	-	-	-	+
8	Quinones	+	-	-	-	-	-	-	-

^{&#}x27;+' sign indicates the presence of the Phytochemicals and '-' sign indicates its absence







REVIEW ARTICLE

Exploring the Landscape of Machine Learning: Challenges **Applications – A Comprehensive Review**

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ABSTRACT

In our modern society, technological dependence is ubiquitous, driving our daily activities. Much like humans learn from past experiences, machines and robots have been engineered to absorb and learn from input data. As researchers and scientists push towards automation, Machine Learning emerges as a pivotal tool in realizing this ambition. Its applications span a wide array of fields, from automating industrial processes to enhancing home appliances. This paper delves into the importance of Machine Learning and its diverse applications, such as speech recognition, robot control, and computer vision. It also explores the promising future prospects of Machine Learning across various technological domains, leveraging a range of algorithms designed to deliver exceptional accuracy rates.

Keywords: Algorithmic Methods, Application Scenarios, Data Sets, Machine Learning Techniques, **Training Processes**





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INTRODUCTION

Machine learning involves the construction and refinement of algorithms aimed at discerning patterns within datasets to facilitate predictions on forthcoming data. The fundamental premise of machine learning entails acquiring extensive datasets comprising input-output pairs, analyzing these datasets to extract patterns, and subsequently employing these patterns to forecast outcomes for future data [1]. This process enables systems to autonomously predict outcomes for various input data based on pre-established algorithms, thus eliminating the need for reprogramming with each new input. A quintessential example of this is evident in search engines, where continuous learning occurs through the exploration [2] of websites and web pages, enabling the provision of pertinent information to users. Machine learning encompasses three primary categories. Figure 1shows the common types of machine learning.

Supervised Learning

Supervised learning is a prominent form of machine learning where users select a suitable dataset, termed the training set, and feed labeled data into the algorithm. The algorithm then analyzes this input data to establish patterns between input-output pairs. Subsequently, when new data is introduced, the system utilizes the developed pattern to compute results based on the provided training set. Figure 2 shows the Workflow of Unsupervised Learning. Supervised learning employs classification algorithms and regression techniques, including linear regression, logistic regression, neural networks, decision trees, support vector [2] machines (SVM), random forests, naive Bayes, and k-nearest neighbor.

Unsupervised Learning

In contrast to supervised learning, unsupervised machine learning operates on unlabeled data. This approach enables systems to autonomously learn from various observations. Cluster analysis is a prevalent method within [1] unsupervised learning, employed for data analysis to uncover patterns or groupings within the data. Figure 3 shows the Workflow of Unsupervised Learning.

Reinforcement Learning

Reinforcement learning is a machine learning paradigm that centers on rewarding the system based on successful outcomes. Utilizing various algorithms, reinforcement learning seeks to determine the most optimal course of action in specific situations. In this form of machine learning, the system determines the subsequent action to undertake to achieve a task. Figure 4 shows the Workflow of Reinforcement Learning. A reinforcement learning [5] system learns and makes decisions based on its experiences, wherein the output relies on the current input, and subsequent inputs are influenced by prior outputs.

Challenges

In the recent years, Machine Learning has proved its usefulness to the world in different fields like computer vision, autonomous cars, etc. and has been very much influential in terms of advancement in technology and accuracy. But on the other hand, it has to overcome some of its limitations in order to achieve greater results.

The limitations which are faced by the Machine Learning are as follows:

Object detection

Object detection and recognition is one of the most commonly used and advanced features of the Open CV which uses a larged at a set consisting of thousands of images of different classes. Now-a-days more advanced algorithms have been developed which enables the user to have a more accurate and precise output. But then also, it faces some difficulties in object detection and recognition due to following reasons[6]:

- i. Optical illusion
- ii. Various view point variations
- iii. Different lighting condition





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iv. Scaling variation as shown in Figure1

Contextual limitation

In the realm of text and speech data comprehension, algorithms have been developed to interpret symbols within the data and construct words, sentences, or meaningful information. These algorithms operate by analyzing the provided dataset, enabling machines to decode mnemonic codes and predict corresponding letters, digits, words, or symbols. However, a significant challenge arises from the fact that machine learning primarily facilitates the reading of input-output data, rather than comprehending it as humans do. Unlike humans, machines struggle to truly grasp the underlying meaning of the information and provide appropriate reasoning based on the data [6]. Therefore, a key objective for machine learning is to advance beyond mere data interpretation and achieve a deeper understanding of information, [5] enabling machines to offer more insightful and reasoned responses based on the analyzed data.

Scalability

In today's fast-paced technological landscape, the exponential growth of data poses a significant challenge to the scalability of machine learning-powered projects. To produce accurate and precise outputs, algorithms must be continuously fed with the latest data in large volumes. However, the dynamic nature of data necessitates human intervention to ensure algorithms remain updated with current trends and patterns. This reliance on human assistance can impede the seamless functioning of projects.

Hence, there is a pressing need to develop advanced machine learning algorithms capable of autonomously updating datasets without human intervention. By implementing automated data updating [6] mechanisms, these algorithms can adapt to evolving data trends in real-time, ensuring the ongoing relevance and accuracy of their outputs. Such advancements would enhance the scalability and efficiency of machine learning projects, freeing up human resources for more strategic tasks and accelerating innovation in the field.

Regulatory restriction for data in machine learning

Machine learning algorithms rely heavily on vast datasets to enhance their accuracy in output generation. However, providing such large volumes of data to algorithms poses challenges for users, particularly when much of this data is privatized by tech firms. Additionally, datasets may contain a mix of general and sensitive information, raising concerns about potential misuse or theft, particularly in sensitive domains such as security, healthcare, and defense. Regulating the data provided to machine learning algorithms is crucial to mitigate risks associated with data theft and piracy. This entails implementing measures to safeguard sensitive information and ensure compliance with privacy regulations. By establishing robust data governance frameworks, organizations can protect against unauthorized access, misuse, and exploitation of data. Furthermore, transparency and accountability mechanisms can help build trust among users and stakeholders, fostering responsible data usage practices. Addressing these concerns requires collaboration between policymakers, industry stakeholders, and technology experts to [7] develop and enforce regulations that strike a balance between innovation and data privacy. By promoting ethical data practices and implementing effective regulatory frameworks, we can foster a secure and responsible ecosystem for machine learning innovation.

Applications

Machine Learning has found its applications in diverse fields in the new era of technology and innovation. Whether it is industrial machines or domestic appliance, Machine Learning is very much essential in terms of productivity, accuracy, pace, etc. [4]. Despite of the limitations, our scientists and researchers have been able to gain success in different areas. Some of the machine learning applications is listed below:





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Speech recognition

Many technologies introduced in today's market are equipped with speech recognition systems, leveraging machine learning to enhance their functionality. These systems undergo training using input datasets, enabling them to improve their accuracy and performance over time [5] [7]. Through machine learning, speech recognition systems can effectively interpret and process spoken language, facilitating seamless interaction between users and devices. As a result, these technologies offer enhanced convenience and accessibility, revolutionizing how we interact with various devices and services in our daily lives.

Computer Vision

Facial detection, facial recognition, object tracking, and other features of computer vision or Open CV as depicted in Figure 6 rely on Machine Learning algorithms trained on pre-built datasets [8]. These algorithms are continually evolving, with ongoing development leading to increasingly accurate results [7]. The figure 6 shows computer vision machine vision. As Machine Learning techniques advance and datasets grow, computer vision capabilities are becoming more sophisticated, enabling a wide range of applications across industries such as security, healthcare, retail, and automotive.

Robotics and automation

Machine Learning has proven to be highly advantageous in the realm of robotics and automation due to its efficient and remarkably accurate algorithms [7]. Google's self-driving cars serve as a prime illustration of the effectiveness of Machine Learning algorithms. By leveraging Machine Learning techniques, these autonomous vehicles can navigate real-world environments [8], detect obstacles, and make informed decisions to ensure safe and efficient transportation. The success of such applications underscores the transformative impact of Machine Learning on robotics and automation, paving the way for innovative solutions to complex challenges in various industries. Figure 7 shows the Google's self-driving car.

Virtual Personal Assistant

Machine Learning is playing a pivotal role in assisting people through various tasks, exemplified by Virtual Personal Assistants (VPAs). Leading companies such as Google, Apple, and Amazon have developed VPAs like Google Assistant, Siri, and Alexa, respectively. These VPAs utilize Machine Learning algorithms to collect speech data from users and convert it into text [5]. Subsequently, the extracted information undergoes further analysis using additional Machine Learning algorithms to generate outputs that align with the user's preferences [8]. By leveraging Machine Learning, VPAs offer personalized assistance, facilitate seamless interactions, and enhance user experiences across a wide range of tasks and applications.

Predictions while commuting

Traffic update systems such as Google Maps and online transportation networks like Uber, Ola, etc., utilize GPS systems to exchange location coordinates. Subsequently, Machine Learning algorithms are applied to refine the results according to user preferences [8]. These systems are trained to incorporate both current input and previous user information, allowing them to deliver tailored results [2]. By leveraging Machine Learning, these platforms offer real-time traffic updates, optimize route planning, and provide personalized recommendations, enhancing user experience and efficiency in transportation services.

Email spam and malware filtering

In today's world, cyber-crime rates have surged significantly, with email spam and malware injection being prevalent forms of cyber-attacks globally. To combat these threats, Machine Learning-powered features such as email spam filtering (as depicted in Fig. 4) and malware filtering have been developed to protect users from such cyber-crimes [9]. These Machine Learning algorithms analyze email content and network traffic patterns to identify and block suspicious emails and malicious software, thereby safeguarding users' digital assets and privacy. By continuously adapting to evolving cyber threats, these Machine Learning-powered security measures play a crucial role in mitigating risks and ensuring a safer online environment for users. Figure 8 shows the Email Spam Filtering.





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Search engine result refining

Google is one of the most visited search-engine in the world which is used by the whole world. In order to improve the user's experience, Google is efficiently using Machine Learning so that it can enhance the user search results. Every time a search is done, the back end algorithm tracks your response towards the results and provides user with even better results next time a search is executed as shown in Figure 9.

Online fraud detection

Machine Learning has proven to be highly effective in enhancing cyber security measures and safeguarding activities in cyberspace. For instance, it is extensively utilized for tracking online transactions and detecting fraudulent activities, such as monetary frauds. Companies like PayPal leverage Machine Learning algorithms to combat money laundering and protect their users [9][10]. Figure 10 shows the Common types of Frauds. These examples highlight just a fraction of the diverse applications of Machine Learning. The extensive adoption of Machine Learning in cyber security underscores its vast potential in addressing complex challenges and enhancing security measures across various sectors. Moreover, the widespread utilization of Machine Learning indicates that it will continue to be at the forefront of technological advancements in the future. As technology evolves, Machine Learning is poised to play an increasingly central role, shaping the future landscape of innovation and driving advancements across industries. Thus, it can be inferred that the future of technology is intrinsically intertwined with Machine Learning.

CONCLUSION

This paper has shed light on the latest advancements and diverse technologies prevailing in today's market, all driven by the application of machine learning methodologies. It emphasizes that machine learning is not merely a tool but a fundamental necessity across various social applications, paving the way for a new era of development and design. By connecting machine learning, we can streamline processes, enhance efficiency, and alleviate the burdens of human effort. As we continue to integrate machine learning into our systems and technologies, we anticipate further innovations and transformative changes across industries, ultimately shaping a more automated and intelligent future.

FUTURE SCOPE

Given the myriad applications of Machine Learning, its future scope is exceptionally broad, extending across every facet of technology. As society becomes increasingly reliant on technology, scientists and organizations continually strive to introduce innovative solutions. While Machine Learning has already permeated numerous technological domains, its potential extends beyond advanced computer vision and speech recognition. These areas represent only a fraction of the potential applications, leaving ample room for further exploration and development. As yet undeveloped fields are poised to integrate Machine Learning in the near future, presenting compelling research opportunities for experts in the field.

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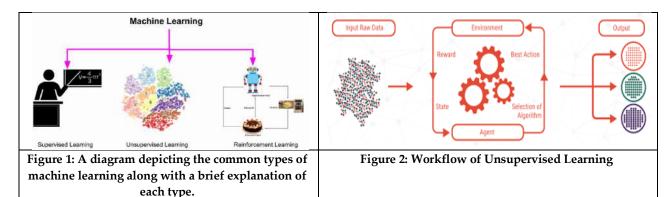
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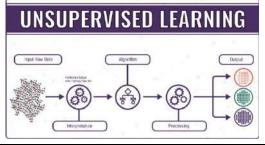


Figure 3: Workflow of Unsupervised Learning



Figure 4: Workflow of Reinforcement Learning





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Figure 5: Scaling Variations

rigure 5: Scaling variations



Figure 6: Computer Vision Machine Vision



Figure 7: Google's self-driving car

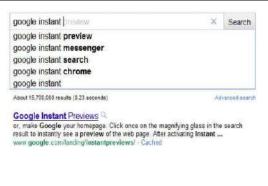


Figure 8: Email Spam Filtering

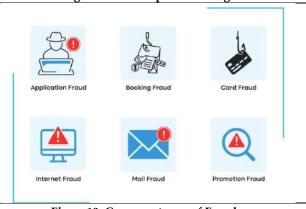


Figure 9: Search Engine Result Refining

Figure 10: Common types of Frauds





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RESEARCH ARTICLE

Chemical **Topological** Degree Based Bonding **Descriptors** in Ophthalmology via Lucky Index

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ABSTRACT

Ophthalmology is an area of medicine that focuses on the health of the eyes. It includes the anatomy, physiology, and ailments of the eye. It is a medical surgical specialization concerned with the diagnosis and treatment of eye problems. The topological indices is associated with each of the drug physicochemical characteristics. The medications used to treat ophthalmology are examined in the current work using the newly defined topological index called lucky index. Any novel medicine must have certain structural characteristics, which can be discovered by QSPR modelling with TIs. The objective of this work is to use newly defined topological index called lucky index in standard graphs and also in chemical structure to quickly and cheaply get information about the topology of a structure.

Keywords: Lucky index, Chemical Graph theory Math Subject Classification: 05C07,05C10,05C92





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INTRODUCTION

An actual number derived from the chemical graph structure is called a topological descriptor also called as topological index. In this paper a new topological index is defined and applied in standard graphs and in chemical structure in the treatment of eye infections. Many medications, including those used to treat eye infections such as blepharitis, Cellulitis, Dacryocystitis (an infection of your tear sac that can happen when your tear ducts become blocked and can't drain properly), Pink eye, Endophthalmitis, Stye, Uveitis can have their physical, chemical, and biological features predicted. With major improvements in drug design, the use of topological descriptors remains the primary strategy. When coupled with QSPR models, descriptors generate numerical representations of a molecule's chemical characteristics. In this article, the medications used to treat eye infections are discussed. The aim of the QSPR study is to determine the mathematical connection between the investigated properties (such as boiling point, flash point, etc.) and various descriptors related to the molecular structure of the medications. Topological indices (TIs) applied to the aforementioned medications have been discovered to have a strong association with physicochemical characteristics in this situation.

PRELIMINARIES

Some known definitions and results related to lucky index of graphs for ready reference to go through the work presented in this paper are discussed in this section.

Def 2.1: A simple graph G consists of a non-empty finite set V(G) of elements called vertices (or nodes), and a finite set E(G) of distinct unordered pairs of distinct elements of V(G) called edges. We call V(G) the vertex set and E(G) the edge set of G.

Def 2.2: The degree of a vertex v of G is the number of edges incident with v, and is written deg(v); in calculating the degree of v, we usually make the convention that a loop at v contributes 2 to the degree of v. A vertex of degree 0 is an isolated vertex and a vertex of degree 1 is an end-vertex.

Def 2.3: A graph whose edge-set is empty is a null graph.

Def 2.4: A simple graph in which each pair of distinct vertices are adjacent is a complete graph denoted by K_n and K_n has n(n-1)/2 edges.

Def 2.5: A connected graph that is regular of degree 2 is a cycle graph and it is denoted by Cn.

Def 2.6: A graph in which each vertex has the same degree is a regular graph. If each vertex has degree r, the graph is regular of degree r or r-regular.

Def 2.7: If the vertex set of a graph G can be split into two disjoint sets A and B so that each edge of G joins a vertex of A and a vertex of B, then G is a bipartite graph.

Def 2.8: A complete bipartite graph is a bipartite graph in which each vertex in A is joined to each vertex in B by just one edge denoted by K_{mn} .

Lucky Index

Motivated by the definition of various indices, a new index called lucky index of a simple graph G is defined. Also, lucky index of the standard graphs is found.

Definition3.1: Lucky index of graph G, denoted by LI(G) is defined as

 $LI(G) = \sum_{i=1}^{n} [(\delta(G) + \Delta(G))^2 - (d(u))^2]$ where $\delta(G)$ is the minimum degree of a graph G and $\Delta(G)$ is the maximum degree of a graph G

Theorem 3.2: For a Cycle Graph, the Lucky index LI(Cn)=12n

Proof: Since Cn is a regular graph of order 2, the minimum and maximum degree of Cn are $\delta(G) = \Delta(G) = 2$. By the definition of Lucky index, $LI(G) = \sum_{i=1}^{n} [(\delta(G) + \Delta(G))^2 - (d(u))^2 LI(Cn)] = n[4^2 - 4]$





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Theorem 3.3: For a Path Graph P_n , the Lucky index LI (P_n) = 5 (n-2) +16 for n.

Proof: Let $v_1, v_1, ..., v_n$ be a path graph with n-1 edges.

Note that $d(u_1) = d(u_n) = 1$ and $d(u_i) = 2$ for $2 \le i \le n - 1$, Clearly $\delta(P_n) = 1$ and $\Delta(P_n) = 2$

$$LI(G) = \sum_{i=1}^{n} [(\delta(G) + \Delta(G))^{2} - (d(u))^{2}$$

$$LI(P_{n}) = (n-2)[3^{2} - 2^{2}] + 2[3^{2} - 1^{2}]$$

$$= 5(n-2) + 16 \text{ for all } n.$$

Theorem 3.4: For a Complete Graph K_n , the Lucky Index LI $(K_n)=3n^3-6n^2+3n$ for all n.

Proof: A Complete Graph K_n contains n number of vertices and all the vertices has (n-1) degree.

 $\delta(k_n) = \Delta(k_n) = (n-1)$

Lucky Index LI (G)= $\sum_{i=1}^{n} [(\delta(G) + \Delta(G))^2 - (d(u))^2]$

LI
$$(K_n)$$
=n[[$(n-1) + (n-1)$]² - $(n-1)$ ²]

LI $(K_n)=3n^3-6n^2+3n$ for all n.

Theorem 3.5: For a Complete Bipartite graph ($K_{n,m}$), LI ($K_{n,m}$) = $6n^3$, for n=m

Proof: Without loss of generality, partition the vector set of the complete bipartite graph $K_{n,m}$ into disjoint sets A= $\{u_1, u_2, ..., u_m\}$ and B= $\{v_1, v_2, ..., v_n\}$ such that no two vertices in either set are adjacent to each other.

Note that $d(u_i)=n$, for all i=1, 2, ..., m.and $d(v_i)=m$, for all j=1, 2, ..., n

Now, Lucky Index LI(G)= $\sum_{i=1}^{n} [(\delta(G) + \Delta(G))^2 - (d(u))^2]$

$$=2n [(n+n)^2 - n^2]$$

= 6n³

Theorem 3.6: The Lucky Index for a Wheel Graph W_n isn^3+3n^2-3n+8

Proof: In General, Wheel Graph W_4 , W_5 , W_n has δ (W_n)=3 and Δ (W_n)=(n-1) for all $n \ge 4$

And the vertices $d(u_1)=(n-1)$, $d(u_2)=3$, for W_n

Lucky Index LI(G)= $\sum_{i=1}^{n} [(\delta(G) + \Delta(G))^2 - (d(u))^2]$

LI
$$(W_n)$$
= $(n-1)[((n-1)+3)^2-3^2]+[((n-1)+3)^2-(n-1)^2]$

LI $(W_n) = n^3 + 3n^2 - 3n + 8$ for all n.

Theorem 3.7: For a Tree T_n , the Lucky index LI (T_n) =52+12(n-4)

Proof: Consider a tree T_n for $n \ge 4$ possess $\delta(T_n)=1$ and $\Delta(T_n)=3$

And Consider d $(u_1)=1$, (3 times for T_n , $n \ge 4$), d $(u_2)=3$, (1 time for T_n , $n \ge 4$),

d (u_3)=2, ((n-4) times for T_{n_i} n≥4)

Lucky Index LI(G)= $\sum_{i=1}^{n} [(\delta(G) + \Delta(G))^2 - (d(u))^2]$

Clearly, LI
$$(T_n)=3[4^2-1]+1[4^2-9]+(n-4)[4^2-4]$$

=52+12(n-4) for all n.

Theorem 3.8: For a Friendship Graph F_n , LI (F_n) ==8 n^3 + 20 n^2 +8n+4 for all n.

Proof: For a Friendship Graph F_n , $\delta(F_n)=2$ for all n and $\Delta(F_n)=2$ n for all n.

Therefore d (u_1) =2 and d (u_2) =2n

Lucky Index LI(G) = $\sum_{i=1}^{n} [(\delta(G) + \Delta(G))^2 - (d(u))^2]$

Thus, LI
$$(F_n) = (2n)[(2+2n)^2 - 2^2] + [(2+2n)^2 - (2n)^2]$$

 $=8n^3 + 20n^2 + 8n + 4$ for all n.

Theorem 3.9: For a Hanoi Graph, the Lucky index LI(H)=447

Proof: Hanoi graph has 27 vertices. Among them 24 vertices have degree, Δ (H)=3 and

the remaining 3 vertices degree, $\delta(H)=2$.

LI(G)=
$$\sum_{i=1}^{n} [(\delta(G) + \Delta(G))^2 - (d(u))^2]$$





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Thus, LI(H)= $24[(3+2)^2 - 3^n] + 3[(3+2)^2 - 2^2]$ =447 for all n.

Theorem 3.10: The Lucky index For a Petersen Graph is 720

Proof: The Petersen Graph have 10 vertices and all vertices have the degree 3

Lucky Index, LI(G) = $\sum_{i=1}^{n} [(\delta(G) + \Delta(G))^2 - (d(u))^2]$

Thus, LI(P)= $10[(3+3)^2-3^2]$

=720

Applications of the lucky index in Medicines

In this section, the lucky index of some of the medicines in the treatment of eye infection are calculated. It is compared with the existing molecular weight, hydrogen bond donor count, hydrogen bond acceptance count, rotatable bond count of the medicines. This type of test can helpful to compare and decide the improvement of model.

Structure of Medicines

The calculated value of diverse linear models for Lucky index degree-based topological index, which are given as under:

Regression models for Lucky index LI (G):

Molecular Weight = 203.665 + 0.271(LI(G))

Hydrogen Bond Donor Count = 1.436 + 0.001(LI(G))

Hydrogen Bond Acceptance Count = 5.070 - 0.004 (LI(G))

Rotatable Bond Count = 2.074 + 0.007(LI(G))

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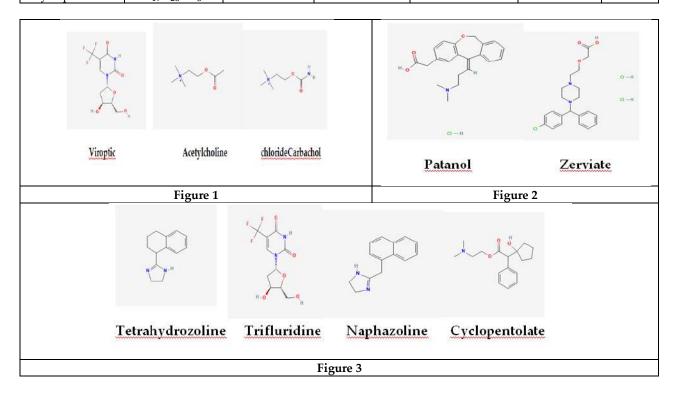




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Table 1

Chemical Name	Chemical Formula	Molecular weight (g/mol)	Hydrogen Bond Donor Count	Hydrogen Bond Acceptance Count	Rotatable Bond Count	Lucky Index
Viroptic	$C_{10}H_{11}F_3N_2O_5$	296.20	3	8	2	142
Acetylcholine chloride	$C_7H_{16}ClNO_2$	181.66	0	3	4	189
Carbochol	$C_6H_{15}ClN_2O_2$	182.65	1	3	4	189
Patanol	$C_{21}H_{23}NO_3$	337.4	1	4	5	267
Zerviate	$C_{21}H_{27}Cl_3N_2O_3$	461.8	3	5	8	288
Tetra- hydrozoline	$C_{13}H_{17}clN_2$	236.74	2	1	1	295
Trifluridine	$C_{10}H_{11}F_3N_2O_5$	296.2	3	8	2	356
Naphazoline	$C_{14}H_{14}N_2$	210.27	1	1	2	316
Cyclopentolate	$C_{17}H_{25}NO_3$	291.4	1	4	7	402







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RESEARCH ARTICLE

Effect of Hammett Substituent Constants on Spectral Frequencies of Bio **Sulfonyl Formamidines**

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ABSTRACT

About ten sulfonyl formamidines have been synthesized and their purities were insected by literature procedure. The characteristic functional frequencies of infrared and nuclear magnetic spectra of these imidines were interrelated with Hammett σ , F, R and Swain-Lupton's constraintsby means of statistical regression analysis. From the statistical regression analysis results, the influence of substituents on the spectral frequencies were predicted. Also, the in-vitro antimicrobic actions of these imidines were measured by Bauer-Kirby disc diffusion method with their antimicrobial strains.

Keywords: Sulfonyl formamidines, IR Spectra, NMR Spectra, Hammett Substituent constants, Bauer-Kirby disc-diffusion method, Antimicrobial activities.





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INTRODUCTION

The (E)-N-sulfonyl formamidines comprising of sulfonamide and imine moieties (-SO₂-NH- and -N=CH-)¹. These compounds have widespread biological activities in natural products and synthetic key intermediates for organic building blocks [1-4]. Scientists and chemists utilized these sulfonyl formamidines for derivingheterocyclics and complexes [3]. Different synthetic methods to construct these motifs have been established [4]. Chang and his coworkers reported a three-component one-pot coupling method for deriving of N-sulfonylamidines [5] with sulfonyl azides, alkynesandan amines. Afterwards, Hu et.al., reported the synthesis of N-sulfonylamidines by the condensation of sulfonyl azides, ynones, and an amide [6].Other synthetic methods to construct N-sulfonyl amidines were also developed [7]. In addition, some approaches through direct coupling between tertiary amines and sulfonyl azides to construct N-sulfonyl formamidines were also reported [8]. The three-component reaction of sulfonamides, alkynes andaminesor with amides [9,10]to synthesize N-sulfonyl amidines (5-9) has also been disclosed. However, these reported protocols suffer from conditions using fiery organic azide [5-8],or corrosive coupling reagents [11]. In some cases, only a limited substrate scope has been demonstrated. Therefore, the growth of a general method to expand current synthetic limitations is in high demand. Copper catalyzed synthesis protocol tolerates a broad scope of numerous (E)-N-sulfonyl formamidines in exclusive (E)-stereoselectivity. Particularly, the reaction is accomplished under mild conditions without the use of a corrosive acid or base as an additive [12]. Also, sulfonyl imidines possess the -N=CH- group and this finds importance in elucidating the mechanism of transamination and racemization reactions in biological systems [13, 14]. Imines are widely applicable in analytical determination, such composition of carbon, nitrogen and hydrogens in metal complexes, determination of substrates with an amino or carbonyl group) using complex formation reactions (determination of amines, carbonyl compounds and metal ions) or using changes in spectral data and PH measurements [15-18]. Thirunarayanan et al., have investigated the synthesis and spectral correlations of various sulfonamides [19-20]. Dineshkumar et. al., [21-27] have synthesized some sulfonamides using greener method and studied the biological activities. Employing ultrasonication synthetic technique, Thirunarayanan [28] synthesized some novel sulfonamides with good yields. From the literature review, there is no report avail for the spectral correlation and evaluation of antimicrobe actions of these sulfonyl imidines in the past and present. Hence the authors interested to synthesis the titled sulfonyl imidines and studied the spectral correlation and antimicrobe actions using Bauer-Kirby disc diffusion method.

EXPERIMENTAL

In the present investigations, the sulfinimides were synthesized and their purities were analyses by literature method[29]. Using the reactions of 1.2 g of phenyl sulfonamides, 1.2 mg of morpholine, 1.9 g of copper bromide and DMSO (7.0 mL)(Scheme-1).

Measurement of Antimicrobial activity

The standard procedure of Bauer-Kirby [30] disc diffusion method was adopted for evaluation of antimicrobe actions of the synthesized sulfonyl imidine. Antibacterial activity of these compounds was measured with each two-gram positive and negative bacterial strains such as *Micrococcus luteus, Staphylococcus aureus, Escherichia coli* and *Pseudomonas aeruginosa*. The antifungal actions of synthesized sulfonyl imidine was assessed using two fungal strains such as *Aspergillus Niger* and *Trichoderma viride*.

RESULTS AND DISCUSSION

Spectral correlations

The characteristic C=N stretches, CH=N chemical shifts of synthesized (*E*)-N-(morpholinomethylene) benzene sulfinimides (1-10) were correlated[31-42] using the Hammett equation as (1 and 2).

$$v = \varrho \, \sigma + v_0 \qquad \dots (1)$$

$$\delta = \varrho \sigma + \delta_0 \qquad \dots (2)$$





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where v_0 and δ_0 are the stretches and the chemical shifts of parent imidines. The assigned $vC=N(cm^-1)$ stretches, CH=N chemical shifts (δ , ppm) of all the substituted (E)-N-sulfonylformamidines in **Table-1**. The $vC=N(cm^{-1})$ stretches of all substituted (E)-N-(morpholinomethylene) benzenesulfinamide correlated satisfactorily with Hammett σ , σ^+ , σ_R constants & R parameters σ (r=0.913), σ^+ (r=0.900), σ_R (r=0.910) and R (r=0.9070). The σ^+ constant gave satisfactory correlation except 4-Br, 3-F and 3-CH $_3$ substituents. The Hammett σ_1 constant and F constrains were failed in regression. The irregularity in the regression was associated with the unstrengthen polar and inductive effect substituents and it associated with resonance-conjugation as per the conjugative assembly of imidine in **Figure 1**. The 1 H NMR chemical shift δ CH=N(ppm) values of all the (E)-N-(morpholinomethylene) benzenesulfinamide have

The 1H NMR chemical shift δ CH=N(ppm) values of all the (*E*)-N-(morpholinomethylene) benzenesulfinamide have shown satisfactory correlations (r=0.901) with σ_1 substituent constant along with negative ϱ values except parent H and 4-NO2 substituents. The remaining Hammett constants σ , σ^+ , σ_R and F & R parameters were failed and poor in correlation. The poor correlation is ascribed to weak polar, field resonance components and associate with geometry as shown in Figure 1. The 13 C NMR chemical shift δ C=N(ppm) values of all the (*E*)-N-(morpholinomethylene) benzenesulfinamideshave usual regression with σ and σ_R constants (σ ; r=0.930 and σ_R , r=0.904) excluding parent(H) substituent. Remaining σ^+ , σ_1 , F & R parameters involved irregular regressions(r<0.900) with 13 C chemicals shifts (δ , ppm) of C=N carbons. Some of the single regression analyses of vC=N(cm-1) stretches, CH=N chemical shifts (δ , ppm) have irregularity in regression with F and R parameters, then the authors moved to statistical multi-regressions[34]. The multi regression analysis of the 13 C NMR chemical shift δ C=N(ppm) values of all (*E*)-N-(morpholinomethylene) benzenesulfinamides with inductive, resonance and Swain-Lupton's [53] parameters displayed regular regression as in equations (3-8).

regular regression as in equations (5 %).	
Γ^{1}) = 1666.548(±3.739)+23.200(±8.199) σ_{I} + 56.963(±11.657) σ_{R}	(3)
n=10, P > 95%)	
$(1) = 1667.469(\pm 4.090) + 24.095(\pm 8.431) F + 50.110(\pm 10.496) R$	(4)
n=10, P > 90%)	
$(\pm 0.026) + 0.192 (\pm 0.005) \sigma_I + 0.064 (\pm 0.008) \sigma_R$	(5)
n=109, P > 90%	
$(200) = 8.175(\pm 0.027) + 0.128(\pm 0.003) F + 0.641 + (\pm 0.007) R$	(6)
n=10, P > 90%)	
pm) = $156.261(\pm 1.120) + 2.717(\pm 2.459)$ $\sigma_I + 0.094(\pm 0.003)$ σ_R	(7)
n= 10, P > 90%)	
$(pm) = 156.232(\pm 1.147) + 2.548 (\pm 0.023) F + 0.091 + (\pm 0.002) R$	(8)
n=10, P > 90%	

Antibacterial activity

The measured antibacterial activity by means of zone of mm of inhibition [25-28, 37-50] of the titled compounds are existed in Table 2. The statistical diagram of this activity was represented in Figure 2. From Table 2, the halogen substituted morpholino phenyl sulphonamides (1-4) shows good antibacterial activity. The methoxy and methyl substituted imidines (5-8) shows moderate activity. The nitro substituted compounds shows least antibacterial action with *Micrococcus luteus strain*. The parent, halogen, 4-methxy, 2-methyl and 4-nitro substituted sulfonyl imidines shows good antibacterial action with *Staphylococcus aureus strain*. The parent and halogen substituted, sulfonamides show better antibacterial activity against *Escherichia coli strain*. Sulfonamides possess H, halogens 4-methoxy and 4-methyl shows good activity against *Pseudomonas aeruginosa* stain.

Antifungal activity

The measured antifungal activity by means of mm of zone of inhibitions [44-47, 65-70] of the sulfonyl imidines are existed in Table 2. The statistical illustrative diagram if the measure antifungal activity was represented in Figure 2. From the table 2, except 4-methyl substituent, all imidines shows good and better antifungal activity against *Aspergillus niger* fungal strain. All imidines except parent compounds shows good and better antifungal activity against *Trichoderma viride* fungal species.





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CONCLUSION

According to the literature method, about ten sulfonyl formamidines were derived and their purities were analyzed. The characteristic infrared and nuclear magnetic spectroscopic data of these imidines were utilized for the investigation of influence of substituenteffects with sigma and Swain-Lupton's constrains through statistical regressions. In statistical mono-regression of infrared vC=N (cm⁻¹) vibrations, Hammett σ , σ , σ , constants & R parameters gave satisfactory correlation coefficients σ (r= 0.913), σ ⁺(r=0.900), σ _R(r=0.910) and R (r=0.907). The σ ⁺ constant gave satisfactory correlation except 4-Br, 3-F and 3-CH₃ substituents. The proton chemical shifts of CH=N(δ , ppm) of all sulfinimides gave satisfactory regression outcomes with Hammett σ ₁ substituent constant along (r=0.901) with negative ϱ values except parent H and 4-NO₂ substituents. The carbon-13 chemical shifts of CH=N(δ , ppm) of all sulfinimides gave satisfactory regression outcomes with Hammett σ and σ _R constants (σ ; r=0.930 and σ _R, (r=0.904) excluding parent(H) substituent. In multi-regression analysis, all assigned spectral frequencies gave satisfactory correlation with Swain-Lupton's σ _L, σ _R and F & R parameters. All compounds show better, good and least antibacterial and antifungal activities against their microbes.

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Table 1. The infrared spectral frequencies(v, cm⁻¹) and NMR chemical shifts (ppm) of N=CH group of substituted (*E*)-N-sulfonylformamidines.

		νN=CH	δН	δ CH=N
1	Н	1654.92	8.101	151.54
2	4-Br	1660.71	8.124	157.70
3	4-Cl	1663.00	8.129	156.70
4	3-F	1654.92	8.133	156.80
5	4-OCH ₃	1649.14	8.182	157.41
6	2-CH3	1659.04	8.201	157.80
7	3-CH₃	1668.85	8.215	157.70
8	4-CH ₃	1663.00	8.181	157.54
9	2-NO ₂	1689.64	8.157	159.40
10	4-NO ₂	1697.56	8.255	157.90

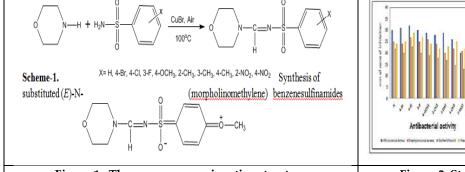


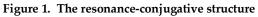


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Table 2. Antimicrobial activities of (E)-N-(morpholinomethylene)benzenesulfinamides

Entry	Х	Zone of inhibition (mm)							
		Antibacteria	al potency			Antifun	Antifungal potency		
		Gram Positi	ive stains	Gram ne	Gram negative stains				
		M. luteus	S. aureus	E. coli	P. aeruginosa	A. Niger	T.viride		
1	Н	30	25	22	24	15	14		
2	4-Br	31	24	20	25	12	17		
3	4-Cl	32	27	23	29	15	19		
4	3-F	30	25	20	27	13	18		
5	4-OCH ₃	29	26	19	24	15	17		
6	2-CH ₃	28	24	18	22	15	16		
7	3-CH ₃	29	20	17	23	14	18		
8	4-CH ₃	26	22	15	25	9	18		
9	2-NO ₂	20	21	13	22	14	18		
10	4-NO ₂	19	24	13	21	11	16		
Charadand	Ampicillin	34	28	24	30				
Standard	Miconazole					18	21		
Control	DMSO								





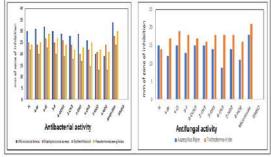


Figure 2. Statistical representation of antimicrobial activities of sulfonyl imidines.





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RESEARCH ARTICLE

Formulation and Evaluation of Poly Herbal Hand wash

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ABSTRACT

One's hands are the main place where bacterial infections spread. Maintaining good hand hygiene is the most crucial, straightforward, and affordable way to avoid nosocomial infections. Keeping your hands clean is the most crucial way to stop infections from spreading. Many of the antiseptic handwashes on the market use alcohol-based sanitizers, which can have negative side effects like dermatitis, dryness, itching, and irritation. The goal of the current study was to create and assess an antimicrobial polyherbal handwash using a variety of herbal plants, including Beta vulgaris (beetroot), Psidium guajava (guava), Azadirachta indica (neem), and Ocimum tenuiflorum (Tulsi). A total of eight polyherbal handwash formulations were created, and each formulation's appearance, colour, Odor, homogeneity, viscosity, pH, foam height, surface tension, and percentage of solid material, test for dirt dispersion. Using the agar well diffusion method, the antibacterial and antifungal activity of Polyherbal Handwash was tested against microbiological cultures of Methicillin Resistant S. aureus, Klebsiella oxytoca and Aspergillus fumigatus. The zone of inhibition results showed a considerable antibacterial and antifungal effect of the polyherbal hand wash. The polyherbal hand wash formulation's action in the culture plates showed a notable





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reduction in the development of bacteria and fungi. It did not cause skin irritation. Consequently, it is possible to manufacture polyherbal hand wash commercially using these plant-based components.

Keywords: Azadirachta indica (Neem), Ocimum tenuiflorum (Tulsi), Mentha arvensis (pudina), Psidium guajava (Guava), Beta vulgaris (Beetroot).

INTRODUCTION

It is a basic practice of personal hygiene and is considered an important tool in the preventive armoury against pathogenic microbes(1-4). An age-old statement "prevention is better than cure" has been seen as remarkably reliable especially in previous pandemics. With an increased availability of hand hygiene focus and awareness, most importantly, due to the situation post-COVID-19, the necessity of handwash formulations provided for excellent removal of microorganisms, but at the same time protecting the health of the skin, has been brought to light. While traditional handwashes sanitize against bacteria and viruses, they contain sodium lauryl sulfate or other synthetic chemicals which breaks down our skin barrier. Such is the disruption that the skin is dry and sensitive skin, making it vulnerable to injury as well as disease. Furthermore, these synthetic surfactants are highly hazardous to aquatic and terrestrial ecosystems and their impact on wildlife and aquatic life has rendered these surfactants a significant danger (5,6). Polyherbal handwashes have appeared as an optimistic tactic to this situation in return These have the combined therapeutic efficacy of herbs which are maximum antimicrobial without any side effects associated with the synthetic chemicals. Sought after for their medicinal qualities, herbs have been a staple of traditional medicine for centuries. These plants contain active antimicrobial compounds and have also been validated in their potential in modern science, such as with alkaloids, tannins, terpenoids, flavonoids, glycosides, phenolic compounds etc.

These agents exert their activity by attacking the cell walls and critical enzymes of the organism thus breaking the microbial resistance (7-9). Azadirachta indica (neem) is a prime example, with its constituents—nimbin, nimbidin, nimbolide, and limonoids-exhibiting significant antibacterial and antifungal activities. Neem's polyphenolic flavonoids enhance skin defense against microbial invasion. Similarly, Ocimum tenuiflorum (tulsi) and mint are renowned for their antimicrobial and skin-nurturing properties. Tulsi's essential oils treat skin infections and enhance radiance, while mint cleanses the skin and maintains moisture balance. Psidium guajava (guava leaf) adds anti-irritation benefits, soothing the skin and countering the harsh effects of traditional handwashes. The development of polyherbal handwashes represents a shift towards formulations that are biocompatible with human skin and the environment, without sacrificing antimicrobial effectiveness. This approach merges ancient wisdom with modern innovation, promoting products that are effective and environmentally friendly. The growing interest in polyherbal handwashes invites researchers, formulators, and consumers to rethink hygiene products, exploring natural resources for sustainable, nurturing solutions. These products embody a commitment to health, sustainability, and environmental stewardship. Polyherbal handwashes symbolize a hopeful future where hand hygiene aligns with health and sustainability, blending tradition with science. As we advance in developing these natural formulations, we envision a future where hand hygiene is synonymous with overall well-being and respect for nature (10-12).

MATERIALS AND METHODS

Methods

Collection

The herbs which are used in the polyherbal handwash were collected from the nearby village Venkataramapuram. These herbs were mostly collected during morning after the dew was dried by using clean sharp scissors.





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Drying

To preserve the medicinal properties of herbs, which were dried thoroughly hanged the bundles of herbs upside down in a cool, dark, and well-ventilated area. Drying times vary but may take 1-2 weeks. Ensure that they were completely dry to prevent Mold.[13]

Size Reduction

After drying, remove leaves, stems, or flowers from the main plant and discard any moldy or damaged parts. Use a mortar and pestle, grinder, or scissors to reduce the herbs to the desired size, such as coarse or fine powder, depending on your type of handwash.

Extraction:[14]

10 grams of each powdered sample were measured and placed into a beaker. 5 ml of ethanol, an effective organic solvent, were added to the powder. Distilled water was then added to bring the total volume to 100 ml, ensuring complete immersion of the powders for better extraction of soluble constituents.

The beaker was tightly wrapped with aluminum foil to prevent contamination, minimize ethanol evaporation, and protect light-sensitive compounds. The mixture was set aside for 72 hours, with gentle agitation every 2 hours to enhance solvent interaction and improve extraction efficiency.

Post-Extraction Processing and Compound Concentration:[15]

After 72 hours, the extract was filtered using filter paper or muslin cloth to separate soluble compounds from residual solids. The resulting liquid extract was carefully collected to prevent contamination or loss.

This liquid extract was transferred to a China dish and heated on a heating mantle at 120°C for 30 minutes to evaporate the solvent. The temperature was monitored to avoid exceeding 120°C, preventing compound degradation or safety risks. After heating, the China dish was cooled to room temperature, yielding a concentrated extract with reduced solvent volume and enriched compounds. This concentrated extract was then ready for further analytical procedures or applications, handled to preserve its quality.

Physical appearance

Organoleptic properties such as color, Odor, homogeneity and appearance of poly herbal handwash formulations were visually inspected

PH:[16]

The sample was systematically diluted with distilled water to achieve a suitable concentration for testing, simulating potential consumer use. The pH of the diluted sample was measured to ensure it fell within the skin's natural range of 5.5 to 7, crucial for avoiding skin irritation and maintaining the skin barrier. The pH confirmation indicated the product's suitability for skin health and integrity.

Determination of viscosity: [17]

A quantitative viscosity assessment of the polyherbal hand wash was conducted. The hand wash was decanted into a funnel above a graduated cylinder, and the time for 100 ml to flow through was recorded. This measurement was repeated twice to ensure consistency and reliability. The documented flow times provided a consistent rate, indicating the hand wash's viscosity, which is crucial for consumer usability and product stability.

Viscosity = flow time (sec) * calibration constant of the funnel

Determination of foam stability: [18]

1-gram sample of the polyherbal hand wash was dispersed in 50 ml of distilled water and transferred to a 500 ml stoppered measuring cylinder. Additional distilled water was added to reach 100 ml. The mixture was agitated with 25 vertical strokes to generate foam and then allowed to stand undisturbed. The height of the foam layer above the 100 ml mark was measured, providing quantitative data on foam stability. This measurement is crucial for assessing





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the hand wash's performance, indicating its ability to produce and maintain foam, which relates to cleaning efficacy and consumer satisfaction.

Determination of percentage solid content:[19]

Percentage solid content in the polyherbal hand wash was determined by quantifying the residue post-solvent removal, executed with precision:

- 1. **Weighing the Empty Container**: Using an analytical balance, the initial weight (W1) of an empty, dry container was meticulously recorded.
- 2. **Sample Preparation**: A precise volume of 100 ml of the polyherbal hand wash was measured for subsequent evaporation.
- 3. **Evaporation of the Solvent**: The sample was transferred into the pre-weighed container and heated at 105°C to evaporate the liquid content, leaving only solids behind.
- 4. **Drying the Residue**: The container was cooled in a desiccator to prevent moisture absorption post-evaporation, ensuring the accuracy of the final weight.
- 5. **Final Weighing**: After cooling, the container with the dried solids was weighed again. This final weight was recorded as W2.
- 6. **Calculation of Percentage Solid Content**: The percentage of solid content was calculated using the formula: Solid content percentage = [(W2 W1)/W1]* 100 In this formula, W1 represented the initial weight of the empty container, and W2 represented the weight of the container with the dried solids. This calculation yielded the percentage of the solid material present in the hand wash relative to the total weight of the sample before drying.

Dirt Dispersion Test:[20]

The Dirt Dispersion Test was designed to evaluate the cleaning efficacy of the polyherbal hand wash in dispersing particulate matter. The experimental setup involved the following steps:

- 1. **Preparation of Test Solution:** A test tube was filled with 10 ml of distilled water to isolate observed effects to the hand wash sample, excluding impurities in the water.
- 2. **Addition of Hand Wash:** 1 ml of the polyherbal hand wash was added to the test tube containing 10 ml of distilled water, mirroring realistic dilution in use.
- 3. **Incorporation of Indian Ink:** A drop of Indian ink was added to the mixture for visual assessment of the hand wash's dispersion capability, chosen for its intense coloration and particulate nature.
- 4. **Mixing the Components:** The test tube was securely stoppered to prevent any spillage or loss of contents.
- 5. **Shaking the Test Tube:** The sealed test tube was vigorously shaken to simulate the mechanical process of hand washing, crucial for effectively dispersing dirt and contaminants.
- 6. **Assessment of Ink Dispersion:** After shaking, the dispersion of ink within the foam was observed and categorized to assess the hand wash's ability to lift and disperse dirt particles, indicative of its cleaning efficacy.

Surface Tension Measurement:[21]

Use a clean stalagmometer, vertically fixed, to measure the number of water drops and their weight (W2) as a reference. Repeat with the sample liquid to determine its mean drop weight (W1), and calculate surface tension using the provided formula.

$$\frac{\partial 1}{\partial 2} = \frac{W1}{W2}$$

W1= weight of sample drops, W2= weight of water drops, $\partial 1$ =surface tension of sample, $\partial 2$ =Surface tension of water





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Anti-Microbial Studies:[22]

The antimicrobial efficacy of the formulated herbal hand wash gel was assessed using the Dip Well Agar Diffusion Technique against *Klebsiella, Staphylococcus aureus, and Aspergillus fumigatus*. Inhibition zones' diameter, compared to standard antibiotic discs like streptomycin, determined efficacy post-overnight incubation at 37°C.

RESULT AND DISCUSSION

Physical Appearance

The distinct colour variations—grey for samples F1 to F4 and brown for F5 to F8—indicate differences in herbal ingredient concentrations, affecting the final product's color. This consistency within each group suggests a controlled manufacturing process, crucial for consumer appeal and perceived efficacy.

Odour

The consistent cinnamon-like scent across all laboratory-prepared herbal handwash samples, despite differing appearances, suggests intentional olfactory consistency in experimental formulations. This standardization ensures meticulous control over variables, crucial for reliable testing outcomes and assessing commercial applicability.

Homogeneity

Homogeneity in laboratory-prepared herbal handwash samples signifies an efficient production process, ensuring consistent physical properties and efficacy. This uniformity is crucial for reliable experimental results, indicating effective ingredient combination methodology and potential scalability for commercialization.

Viscosity

The viscosity of herbal hand wash samples ranges tightly from 50 to 52 cP, indicating precise control in manufacturing for consistent flow properties. This consistency ensures a predictable user experience and maintains quality perception, crucial for consumer satisfaction.

pΗ

The hand wash formulations exhibit consistently slightly alkaline pH values ranging from 8.9 to 9.9, suitable for skin contact and effective cleansing without compromising the skin's natural barrier. This pH range aids in breaking down oils and dirt for enhanced cleansing action while remaining within safe limits for periodic skin contact.

Foam Stability

The foam stability of the hand wash formulations varies from 330ml to 360ml, indicating consistent and substantial foam production across samples. This suggests a similar user experience in terms of foam feel and longevity, meeting consumer expectations for effective cleansing. Factors influencing stability include surfactant types, additives, and pH levels. Overall, stable foam aids in lifting dirt and oils for thorough cleaning, enhancing perceived product quality and efficacy.

Percentage of solid content

The solid content in hand wash formulations ranges from 0.029% to 0.043%, ensuring fluidity and ease of dispensing while subtly influencing rheological properties. Maintaining an equilibrium in solid content is crucial for cleansing efficacy and product consistency without compromising spreadability.

Dirt dispersion test

The dirt dispersion test uniformly reports 'light' outcomes for all hand wash samples, suggesting effective soil removal and surfactant activity. The surface tension values, ranging from 14.03 to 19.25, indicate efficient cleaning power, with lower values facilitating better wetting and dirt removal.





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Surface tension

Surface tension measurements for the hand wash formulations range from 14.03 to 19.25 dynes/cm, indicating varied interfacial tension properties. Lower values compared to water suggest highly effective surfactants, enhancing spreadability and dirt removal. This promotes better wetting of the skin, facilitating efficient cleaning and pathogen removal, ensuring a satisfying user experience crucial for hand hygiene. Results indicate polyherbal handwash's concentration-dependent antibacterial and antifungal activities, more effective against Gram-positive bacteria and fungi than Gram-negative bacteria. Efficacy increases gradually with concentration, with significant effects observed against Staphylococcus aureus and Aspergillus fumigatus.

CONCLUSION

The polyherbal handwash exhibits potent antimicrobial and antifungal properties, particularly effective against Gram-positive bacteria and fungi. It demonstrates favorable physical characteristics and production consistency, meeting consumer expectations. Its natural, environmentally friendly formulation aligns with growing demand for sustainable products. Future research could focus on optimizing antimicrobial spectrum and user experience, solidifying its market position and promoting effective hand hygiene.

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Table 1: Materials required for the poly herbal handwash

	-	for the poly nerval handwash				
S.	Crude Drugs &	Manufacturer				
No	Chemicals	Transactures				
1	Neem Leaves	Collected from the nearby village venkataramapuram.				
2	Aloe Vera Stems	Collected from the nearby village venkataramapuram				
3	Tulsi Leaves	Collected from the nearby village venkataramapuram				
4	Guava Leaves	Collected from the nearby village venkataramapuram				
_	Beet Root (Tap					
5	Root)	Purchased from local market in Tirupati				
6	Mentha Leaves	Collected from the nearby village venkataramapuram				
7	Soap Nut Fruit	Collected from the nearby village venkataramapuram				
8	Cinnamon Oil	Salvia cosmeceuticals Pvt.Ltd. New Delhi -110015 (India)				
9	Come Chamala	Weikfield Foods Pvt. Ltd. Weikfield Estate, Gat No – 485, Lanikand Nagar Road,				
9	Corn Starch	Taluka-Haveli, Dist. – Pune 412216. Maharashtra,India.				
10	Ethanol	Jesday Pharmaceuticals Road No. 9, Plot No. 10&11, Nachaeram, Hyderabad-500078.				
11	Purified Water	Azeez DI Water – 16-1-155A, Netaji Road, Tirupati-517501.				

Table 2: composition of polyherbal handwash compounds

S. No	Name of the Extract	Name of the Extract Colour Consister		Percentage Yield (W/W)
1.	Mint Leaves Extract	Green	Thick	2.48%
2.	Beetroot Extract	Bluish Red	Thick	3.068%
3.	Guava Leaves Extract	Green	Thick	2.54%
4.	Tulsi Leaves Extract	Dark Green	Thick	3.329%
5.	Neem Leaves Extract	Green	Thick	3.855%
6.	Soap Nut Fruit Extract	Brown	Thick	3.024%





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Table 3: Composition of developed polyherbal formulations

S.No	Contents	F1	F2	F3	F4	F5	F6	F7	F8
1.	Neem leaves	3 gm	3gm	4gm	5 gm	0 gm	10 gm	10 gm	10 gm
2.	Aloe vera gel	3 gm	5 gm	5 gm	6 gm	10 gm	12 gm	10 gm	10 gm
3.	Tulsi leaves	3 gm	4 gm	5 gm	7 gm	9 gm	0 gm	10 gm	10 gm
4.	Beet root	1 gm	3 gm	4 gm	5 gm	6 gm	8 gm	10 gm	10 gm
5.	Guava leaves	2 gm	3 gm	5 gm	6 gm	10 gm	12 gm	10 gm	10 gm
6.	Cinnamon Oil	2 gm	3 gm	3 gm	4 gm	5 gm	8 gm	5 gm	10 gm
7.	Corn starch	2 gm	3 gm	4 gm	5 gm	6 gm	10 gm	5 gm	10 gm
8.	Mentha leaves	2 gm	3 gm	5 gm	6 gm	7 gm	5 gm	10 gm	10 gm

Table 4: Evaluation of developed polyherbal Formulations

S.	Physical	or acterope	- polymero						
5. N o	evaluation parameters	F1	F2	F3	F4	F5	F 6	F7	F8
	Physical								
1.	appearance	Grey	Grey	Grey	Grey	Brown	Brown	Brown	Brown
		Cinnamo	Cinnamo	Cinnamo	Cinnamo	Cinnamo	Cinnamo	Cinnamo	Cinnamo
2.	odour	n Like	n Like	n Like	n Like	n Like	n Like	n Like	n Like
3.	Homogeneit y	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4.	viscosity	50cP	51cP	52cP	50cP	51cP	52cP	51cP	52cP
5.	рН	9.1	9.8	9.4	9.9	8.9	9.3	9.7	9.5
6.	Foam stability	350ml	340ml	360ml	350ml	340ml	360ml	330ml	350ml
7.	Percentage of solid content	0.042	0.040	0.043	0.041	0.036	0.033	0.029	0.039
8.	Dirt dispersion test	Light	Light	Light	Light	Light	Light	Light	Light
9.	Surface tension	14.03	15.95	16.01	16.97	17.31	18.95	19.01	19.25

Table 5: Antibacterial & Antifungal activity of polyherbal handwash

	Conc Of Sample & Zone of Inhibition (In mm)				
_	50 μl	75 µl	100 µl		
Gram - Positive Bacteria:		27.5			
Staphylococcus aureus	15mm	18mm	18mm		
Gram - Negative Bacteria:					
Klebsiella oxytoca	11mm	11mm	13mm		
Fungus:		-0.2504			
Aspergillus fumigatus	20mm	20mm	21mm		





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Figure 1: Extraction of materials used in the Polyherbal handwash.



Figure 2: Filtration of materials used in the polyherbal hand wash

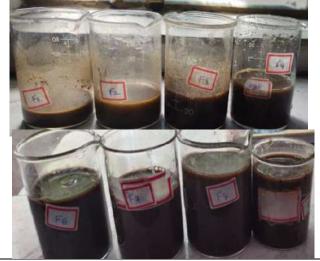


Figure 3: physical appearance of polyherbal handwash formulations



Figure 4: Foam stability of polyherbal handwash







Klebsiella oxytoca



A. fumigatus

Figure 5:Anti-bacterial and Anti-fungal activity of polyherbal hand wash treated bacteria





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RESEARCH ARTICLE

Genetic Algorithm (GA) based Layered Recurrent Neural Network and Improved Cuckoo Search Optimization (GALRNN - ICSO) Technique in **Dysarthria Speech Disorder Recognition**

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ABSTRACT

Dysarthria one of the types of Neuro-motor speech disorder, is referred to as the recurrent indication of several neurological disorders with stroke, Parkinsonism, and traumatic brain injury. It is also claimed that dysarthria affects a person's overall potential, speech accessibility, and capacity to collaborate and connect with others when performing daily tasks. To achieve improved accuracy measures, optimisation and learning patterns are necessary for a novel, effective method of voice recognition for dysarthria. In this , Cuckoo Search Optimization Technique is used for better accuracy results. For the purpose of speech recognition in dysarthria, the Layered Recurrent Neural Network Improved Cuckoo Search Optimisation (GALRNN-ICSO) approach is based on the Genetic Algorithm (GA) is used.

Keywords: Dysarthria, Cuckoo, Genetic Algorithm, Speech Recognition, Neural Networks.

INTRODUCTION

Progressive neurological conditions such Parkinson's disease, motor neuron disease, sclerosis, and Huntington's disease can cause dysarthria, a communication disability[1].Dysarthria affects a person's capacity to connect and interact with others in everyday circumstances as well as their ability to communicate and understand their speech. This sort of disease is linked to the disruption of the brain region that is primarily in charge of speech production [2] Due to the wide range in acoustic features, an automatic speech recognition technique used over the





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speech signals of healthy persons is ineffective when applied to the speech signals of dysarthria people. Speech signals from dysarthria sufferers have disruption and time variation, which leads to imprecise recognition outcomes. The main problem to be solved for increasing understandability is speech defect identification. People with speech recognition difficulties are impacted by a variety of factors, such as noise in the seen signal and variations in lung capacity between normal and affected individuals. The GA-based Layered Recurrent Neural Network Improved Cuckoo Search Optimisation (GALRNN-ICSO) method for dysarthria speech recognition is a revolutionary approach that is presented in this paper. The primary goal of the proposed GALRNN-ICSO approach is to improve test accuracy via F-Measure as well as recall rate and precision when identifying dysarthria speech. Three distinct phases are implemented in order to accomplish the goal of the GALRNN-ICSO approach. For major dysarthria speech recognition, they are: optimal feature selection; relevant feature (i.e., relevant speech signal); and diagnosis.

RELATED WORK

A new approach to voice recognition for dysarthria employing the already-existing CNN DSRM [3] was proposed, but the performance was not up to par because to a highly imbalanced class distribution. The most recent paper to be presented used Levenberg Marquardt analysis and was called K Nearest Neighbor-based Dysarthria Speech Recognition Method (KNN-DSRM) [4]. Although back propagation improved on false positive and false negative parts, it concentrated less on the positive and negative aspects of training. Additionally, the speech recognition method Naïve Bayes-Dysarthria [5]was developed for voice recognition on the basis of conditional random fields, thereby leading to accuracy above average. Because of the inaccuracy of the test, the classifier output quality was not evaluated. Thus, in order to obtain improved accuracy measures, optimisation and learning patterns are necessary for a new and effective method of voice recognition for dysarthria. The GA-based Layered Recurrent Neural Network Improved Cuckoo Search Optimization (GALRNN-ICSO) method for Dysarthria Speech Recognition is a revolutionary technique that is presented in this paper. The suggested GALRNN-ICSO method's primary goal is to improve test-accuracy measurement via F-Measure as well as the precision and recall rate while recognizing Dysarthria Speech. Three distinct stages are put into practice in order to accomplish the goal of the GALRNN-ICSO approach. For substantial Dysarthria Speech Recognition, they are optimal feature selection, relevant feature (i.e., relevant speech signal), and diagnosis.

METHODOLOGY

In this paper a GA-based Layered Recurrent Neural Network Improved Cuckoo Search Optimization (GALRNN-ICSO) is presented. The proposed GALRNN-ICSO method is split into two sections. They are feature subset selection and diagnosis. First, feature subset selection or important features are selected by means of Improved Cuckoo Search Optimization algorithm [6]. The term "improved" here refers to grouping similar wave bands using K-Means clustering and then optimising by choosing a feature subset using Cuckoo Search. Figure 1 given below shows the block diagram of GALRNN-ICSO. As illustrated in the above figure, three steps are followed for assessment of dysarthria diagnosis. These are the diagnosis of dysarthria, lung capacity estimation, and feature subset selection. To choose the feature subset as best as possible, the input voice signals are initially subjected to Clustered Cuckoo Search Optimisation. Based on the energy analysis, lung capacity estimation for men and women is then carried out independently. Finally, Layered RNN is used to evaluate the diagnosis of dysarthria. Below is a detailed explanation of the suggested GALRNN-ICSO approach.

Clustered Cuckoo Search Optimized Feature Subset Selection

In this section, Clustered Cuckoo Search Optimized (CCSO) feature subset selection or important features are selected by means of Improved Cuckoo Search Optimization algorithm. Here, the improved refers to the application of K-Means clustering to group similar wave bands with similar lung air flow and then optimizing using Cuckoo Search to select feature subset. Correlating prospective solutions (i.e., significant features) with cuckoo eggs (i.e., voice signals) is crucial when dealing with CSO algorithms. First, the EGG signals of individual dysarthria patients





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are obtained. Cuckoo Search is used to collect the most beneficial characteristics from the speech data. In this case, the following methods are employed [7]: First, energy and entropy values are obtained by analysing the wavelet

Input: Speech Signals 'SS = SS₁, SS₂, ..., SS_n', Patients 'P = $P_1, P_2, ..., P_n$ '

Output: Optimized feature selection ' $FS = FS_1, FS_2, ..., FS_n$ '

- 1: Begin
- 2: **For** each Speech Signals 'SS' with Patients 'P'
- 3: Split speech signals into two sub bands

//Initialization

4: Perform initialization of speech signals

//Fitness function

5: Evaluate energy and entropy using

//clustering

- 6: Perform clustering based on energy and entropy //Switching parameter
- 7: Evaluate local random walk
- 8: Evaluate global random walk
- 9: **Return** (optimal features)
- 10: End for
- 11: End

packet coefficient in distinct sub bands. K-Means Clustering is used in the process of organising wave sub-bands that are comparable. This will obtain the necessary best values from each voice sample. The database stores the features that are required for speaker recognition. Figure 2 shows the block diagram of Clustered Cuckoo Search Optimized Feature Subset Selection model. The pseudo code representation of Clustered Cuckoo Search Optimized Feature Subset Selection is given below.

Optimized Feature Subset Selection

As given in the above Clustered Cuckoo Search Optimized Feature Subset Selection algorithm, for each speech signals of different provided as input via Torgo Dataset, initially, the speech signals are split into sub bands and energy, entropy of each sub bands are measured [8]. After that, clustering is carried out, and at the end, speech signals with strong correlation are accepted by balancing local and global random walks using switching parameters. and considered as optimal features whereas the speech signals possessing low correlation is neglected and considered as irrelevant.

RESULTS AND DISCUSSIONS

The performance of proposed and existing methods is analyzed with the help of tables and graph values using three different metrics.

- Accuracy
- RMSE

Performance measure of Accuracy

First, the performance measure of accuracy is evaluated for the significant assessments of dysarthria. The accuracy here refers to the number of speech signals correctly analyzed as being diagnosed with the patients having the disorder. This is mathematically expressed as given below.

$$A = \sum_{i=1}^{n} \frac{LC(SS_{CR})}{SS_i} \tag{4.1}$$

From the above equation (4.1) the accuracy factor 'A' is measured based on the speech signals correctly diagnosed ' SS_{CR} ' by considering the lung capacity 'LC' to the speech signals considered for simulation ' SS_i '. It is measured in





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terms of percentage (%). From the above observation as provided in table the results shows that the rate of accuracy considering the lung capacity is better using proposed GALRNN-ICSO when compared to the existing methods

Performance measure of RMSE

Table 2 given above shows the RMSE for 150 different speech signals collected at different time intervals and analysis is made for four different methods. The minimum RMSE was due to the application of GA-based Layered Recurrent Neural Networks algorithm where the fitness value was obtained based on the argmin function that obtained the input relevant feature for which the specified function attained its minimum value.

CONCLUSION

In order to achieve balanced class distribution with least error, a unique GA-based Layered Recurrent Neural Network Improved Cuckoo Search Optimisation (GALRNN-ICSO) approach for Dysarthria Speech Recognition is provided in this paper. The GALRNN-ICSO method improves accuracy with minimum RMSE therefore improving assessment of dysarthria speech disorder. Three distinct processes are involved. They are feature subset selection, relevant feature selection via lung capacity estimation and diagnosis. First, Clustered Cuckoo Search Optimized Feature Subset Selection is applied to the input speech signals to enhance the accuracy along with precision and recall. Furthermore, the subsequent assessment of lung capacity for each gender is carried out independently using energy computed to yield the pertinent characteristic (i.e. signal). Finally, diagnosis is made by applying Layered RNN, where three layers are utilized, with GA being performed in the hidden layer for robust assessment of disorder. In comparison to existing state-of-the-art approaches, the experimental results indicate that the recommended GALRNN-ICSO method delivers accuracy with precise assessment of disorder.

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Table 1: Tabulated results of Accuracy

	Accuracy (%)							
Number of speech signals	Proposed GALRNN- ICSO	NE-DSRM	Existing NB- DSRM	Existing KNN- DSRM				
15	97.03	93.97	87.95	92.77				
30	96.25	93.25	86.35	91.55				
45	96	93.15	86	91				
60	95.85	93	85.55	90.85				
75	95.35	92.85	85.15	90.65				
90	95	92.55	85	90				
105	94.75	92.15	84.85	89.35				
120	94.55	.92	84.35	89.15				
135	94	90.55	84.15	87.25				
150	93.55	90.25	84	86				

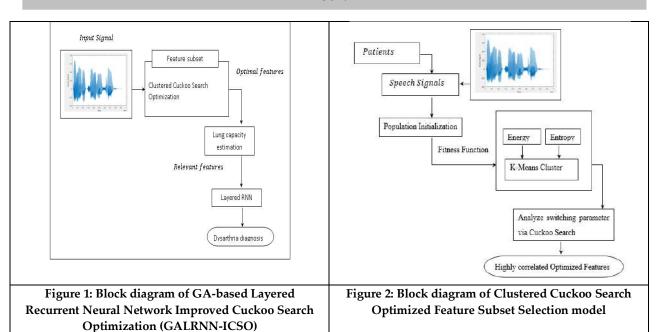
Table 2: Tabulated results of RMSE

	Precision (%)							
Number of speech signals	Proposed GALRNN- ICSO	NE-DSRM	Existing NB- DSRM	Existing KNN- DSRM				
15	96.56	80.15	77.5	47.23				
30	95.15	79.15	75.25	49.15				
45	94	79	74.15	49				
60	94.8	78,85	74	48.85				
75	94.65	78.55	73.85	48.55				
90	94.35	78.15	73.75	48.15				
105	93.15	78	73.55	48				
120	93	77.55	73	47.75				
135	92.55	77.35	72.15	47.25				
150	92.45	77	72	47				





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RESEARCH ARTICLE

Semilunar Flap Reconstruction: A Case Report with Comprehensive CTG and PRF Utilization

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ABSTRACT

Gingival recession, where gum tissue shifts below the cementoenamel junction, exposing the tooth root, necessitates intervention to prevent sensitivity, root caries, and aesthetic issues. The coronally advanced flap (CAF) with a subepithelial connective tissue graft (SCTG) is the preferred method for achieving effective root coverage. Modern periodontal treatment emphasizes not only tooth preservation but also a healthy and aesthetically pleasing gingival appearance, particularly in the aesthetic zone. Various surgical procedures exist to correct mucogingival recession, each with varying success rates, requiring careful treatment planning. This report presents a case using a modified semilunar coronally advanced flap combined with SCTG to address recession on tooth 11. The procedure achieved satisfactory root coverage, which remained stable after 3 months, highlighting the technique's efficacy.

Keywords: Gingival recession, modified semilunar coronally advanced flap, connective tissue graft, semilunar incision





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INTRODUCTION

Gingival recession occurs when the tooth is exposed due to the downward movement of the gingival [4]. It can be caused by various factors, including periodontal disease, mechanical trauma, tooth malposition, root prominence, aberrant frenal attachment, orthodontic treatment, alveolar dehiscence, gingival phenotype, and iatrogenic factors related to restorative and periodontal treatment [4]. This condition is prevalent among dental patients and affects both oral health and aesthetics, leading to concerns such as dentinal hypersensitivity and aesthetic issues [1]. Addressing gingival recession is essential to prevent complications like root caries, cervical abrasion, and the progression of periodontal disease [3]. The 2018 World Workshop categorized gingival recession defects into three types: recession type 1 (RT1) with no loss of interproximal attachment, recession type 2 (RT2) with interproximal attachment loss less than buccal attachment loss, and recession type 3 (RT3) where interproximal attachment loss exceeds buccal attachment loss [17]. Initially, Sullivan and Atkins classified the recession in 1965 into shallow narrow, shallow wide, deep narrow, and deep wide categories. Later, P.D. Miller's classification in 1985 included Class I to IV based on the extent of recession and associated tissue loss [18]. Various procedures are available for root coverage, including free gingival autografts, free connective tissue autografts, and pedicle autografts such as the laterally positioned flap and coronally positioned flap. Additional techniques include subepithelial connective tissue grafts, guided tissue regeneration, and the pouch and tunnel technique. Different pedicle grafts involve rotational flaps like laterally positioned, double papilla, and transposition flaps, as well as advanced flaps such as the coronally advanced flap and semilunar flap [19]. Root coverage procedures aim to restore the natural contour of the gingiva, enhance aesthetics, and relieve discomfort associated with gingival recession [4]. The subepithelial connective tissue graft (SCTG), introduced in 1985, is an effective treatment for denuded root surfaces. However, its technical complexity and the need for two surgical sites may present challenges for some practitioners [5,6]. In 1986, the semilunar coronally positioned flap (SCPF) procedure was introduced to simplify root coverage techniques, improve reproducibility, and optimize cost-benefit ratios [7]. The SCPF offers advantages such as reduced flap tension and the elimination of sutures [12]. To evaluate the long-term outcomes of the SCTG and SCPF for Miller Class I gingival recession abnormalities, a prospective, randomized, controlled clinical trial has been initiated [8]. This study focuses on aesthetic outcomes and the severity of post-surgical pain. Additionally, it examines the advantages and limitations of the modified semilunar technique, particularly for Miller Class I and II recession deformities [9]. This comprehensive study aims to provide valuable insights into the effectiveness and comparative benefits of different root coverage methods, ultimately advancing the field of periodontal plastic surgery and enhancing patient care [10].

Case Presentation

A 36-year-old female patient presented to the outpatient department of the Department of Periodontics at Sree Balaji Dental College and Hospital with the primary concern of receding gums in the upper central incisor (tooth number 11). The patient had no prior dental history, reported no faulty tooth brushing or parafunctional habits, and had not taken any antibiotics in the preceding six months. Additionally, she did not have any prostheses in the anterior region, nor had any teeth received restorative therapy. Her medical history was unremarkable. Upon intraoral examination, Class I Miller's gingival recession was noted on tooth number 11. Clinical measurements indicated a recession defect of 3mm and a width of keratinized tissue of 4mm, measured using a UNC 15 periodontal probe. Clinical photographs were taken before and after surgical therapy. Intraoral periapical radiographs (IOPA) revealed no bone loss in the area of tooth 11. Subsequently, a recession coverage procedure was planned, explained to the patient, and written consent was obtained. Pre-surgical preparation included scaling and root planning to ensure the surgical area was free from plaque. Additionally, the correct tooth-brushing technique was demonstrated to the patient.

Surgical Procedure

Following the administration of local anesthesia using lignocaine (2%), a crevicular incision was made on tooth 11. Subsequently, a tunnel was created by separating the mucosa from the underlying periosteum. A semilunar incision, conforming to the curvature, was then placed apically to the marginal gingiva of the affected tooth, with its





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apicalmost extent situated in the alveolar mucosa. This incision curved laterally and lay coronally within the keratinized gingiva, positioned apical to both the mesial and distal interdental papillae, while ensuring the maintenance of flap vascularity (Figure 1). A connective tissue graft (CTG) obtained from the palate in the regions of teeth 24, 25, and 26 was meticulously positioned beneath the coronally advanced semilunar flap (Figures 2 and 3). The donor site on the palate was sutured using 3.0 Vicryl sutures (Figure 4). Intravenous blood was drawn into a 10-ml test tube to create a platelet-rich fibrin (PRF) membrane following the standard protocol established by Choukroun (Figure 5). Subsequently, the advanced flap, along with the connective tissue graft, was anchored securely in position using an anchor suture on the buccal surface of the tooth (Figure 6). Following the procedure, the patient was provided with post-operative instructions and prescribed suitable antimicrobials and analgesics. Suture removal was scheduled for 10 days post-surgery, after which the patient was enrolled in a periodontal maintenance regimen (Figure 7). A satisfactory root coverage was observed and remained stable even after 3 months. For visual aid and better understanding, refer to the schematic diagram provided.

DISCUSSION

The gold standard treatment for gingival recessions is often cited as a coronally advanced flap (CAF) combined with a subepithelial connective tissue graft (SCTG). This approach is favored for its high success rate in achieving complete root coverage. When deciding between these techniques, factors such as recession depth, width, and individual patient considerations come into play. These factors heavily influence the treatment approach chosen. Ultimately, the decision should be grounded in a comprehensive clinical assessment, taking into account factors like recession characteristics, patient preferences, and the expertise of the treating clinician. By carefully considering these aspects, optimal functional and aesthetic outcomes can be achieved for each patient [20]. The new semilunar coronally repositioned flap technique for managing gingival recessions offers several key advantages, such as tension-free flap repositioning, which promotes optimal healing and reduces complications; preservation of vestibular depth, which maintains the natural appearance of the gingiva; cosmetic preservation of papillae, which ensures a harmonious gingival contour and an attractive smile; and elimination of sutures, which simplifies postoperative care and reduces discomfort, potentially leading to faster healing [8]. The technique described combines the advantages of the semilunar coronally positioned flap (SCPF) and subepithelial connective tissue graft (SCTG) techniques, offering several benefits in managing isolated gingival recessions. This approach minimizes disturbance to adjacent interdental papillae and avoids shortening of the facial vestibule while also reducing flap tension. It is particularly effective for predictable root coverage procedures [13].

In addition to preserving adjacent interdental papillae, this technique minimizes traction and maintains gingival height, resulting in minimal trauma at the recipient site due to the minimal incision. This can be advantageous for masking recessions compared to traditional methods like the coronally repositioned flap. Utilizing one vertical incision facilitates the placement of connective tissue, combining the advantages of subepithelial grafting with a semilunar incision and tunnel procedure, thereby enhancing outcomes [14]. This technique synergizes the advantages of subepithelial grafting with the semilunar incision and tunnel procedure, resulting in enhanced outcomes. The Subepithelial Connective Tissue Graft (SCTG) procedure offers benefits such as improved tissue blending at the grafted site, which contributes to the overall success of the treatment [11]. The recipient site benefits from a dual blood supply, which is crucial for procedure success. In the presented case, the novel combination of SCPF and CTG resulted in 100% root coverage, demonstrating its efficacy [15]. The tunnel approach, an advancement in periodontal surgery, involves a split-thickness flap on the buccal aspect, often combined with a subepithelial connective tissue graft (SCTG) for better outcomes. Proper diagnosis is crucial for selecting the right procedure for root coverage [6]. In the case presented, a combined semilunar coronally positioned flap (SCPF) with CTG achieved 100% root coverage, showcasing its effectiveness.





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CONCLUSION

This case report underscores the efficacy of a modified semilunar coronally advanced flap technique in combination with subepithelial connective tissue grafting for the management of gingival recession defects. The treatment approach resulted in complete root coverage, demonstrating its effectiveness in addressing gingival recessions and enhancing periodontal health [5]. By utilizing this combined technique, which incorporates the advantages of both flap advancement and connective tissue grafting, optimal outcomes were achieved. The preservation of gingival aesthetics, including the maintenance of interdental papillae and vestibular depth, highlights the cosmetic benefits of this approach [4]. Overall, this case reaffirms the value of a tailored treatment approach in periodontal therapy, emphasizing the importance of selecting appropriate techniques based on individual patient needs and clinical considerations [8]. Further research and clinical studies may provide additional insights into the long-term outcomes and success rates of this combined approach, contributing to the advancement of periodontal treatment protocols.

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Figure 1: a) Semilunar incision in the region of 11

Figure 1: b) partial thickness flap was separated





Figure 2: connective harvested from 24, 25, 26 regions

Figure 3: Harvested connective tissue







Figure 4: Suturing of the donor site with 3.0 Vicryl suture.

Figure 5: PRF membrane (platelet-rich fibrin)





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Figure 6: a) Flap with connective tissue graft was placed at recipient site b) 3.0 Vicryl suture is done on the buccal surface



Figure 7: Post operative of 1 week





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RESEARCH ARTICLE

Image Captioning Model using Image Classification

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ABSTRACT

Now a day, describing the content from image in natural language draw much attention. Various sources of images like newspaper, social media, web and many more. we propose an image captioning model using image classification, Object detection, attention mechanism and LSTM. This model consciously classifies the image and generated text. Meanwhile objects detected using object detection algorithm. By fine tuning all the parameters, attention model also added more image related features and finally LSTM generate the caption. Image classification can guide the captioning process by providing high-level information about the primary subject of the image. Objects detected using YOLOv4 Algorithm. Flickr8k, COCO benchmark datasets are use in our experiment. The Output evaluate using BLEU score.

Keywords: Convolution Neural Network, LSTM, Natural Language Processing, Deep Learning, Image classification

INTRODUCTION

Image captioning is multi-disciplinary task for industry and academia (Cao et al., 2019). Computers can reduce responsibility of humans with effectively, accurately and automatically. Image captioning means description generated from image in natural language automatically. In the 21st century human takes selfie-photo with blurring background and also used single object image, with this image-features algorithm not accurate extract features from the images and it take huge time to train. On the other hand, the image classifier algorithm takes less time compare to it and it classify the image into single word. In this paper Deep learning based image captioning[1], [2] method





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studied in detail. Image as input, encoder section encodes all features using Object detection and image classification methods. Affecting vectors reflect and set attention mechanism and LSTM used in decoder section and finally generate the output sentence in between start sequence and end sequence. There are two types of image classification one is single class predicted and other is multi-class predicted, both have its own advantages but multi-class image classification technique is more suitable DenseNet CNN architecture is used for image classification and YOLOv4 [3] is used to detect multiple objects. This encoder section is another alternative of other model's [4], [5], [6] encoder section.

RELATED WORK

Image captioning broadly classified into three main categories Retrieval-based, Template-based and deep learning-based image captioning. Template-based image captioning contain fixed templates with a number of blank slots. Based on different objects detection, attributes, relationship filled the blank space and finally the caption is generated. Many researcher work on this methods[7], [8], [9] later on modification done in this techniques, parsing methods added in existing method for accurate output. Retrieval based method have large data set in which pre-define sentences and images are stored, based on matching with input image[10], [11], [12] the sentences is generated as an output. The output sentence is grammatically and syntactically true but some time the output is not the related with image. This is the main drawback of retrieval-based image captioning method. Deep-learning based image captioning broadly classify into different categories such as encoder-decoder based image captioning, attention-based image captioning, dense image captioning and many more.

Encoder-decoder based image captioning technique deeply reviewed in this paper. Zhang et al., 2023[13] This approach has demonstrated its effectiveness in capturing the semantic information of images and generating coherent captions that accurately describe the visual content [14], [15](Furthermore, the encoder-decoder architecture has been widely adopted in various image captioning tasks, including remote sensing image captioning, computer vision, natural language processing, and video captioning[16], [17], [18]. The use of deep learning-based encoder-decoder models has shown promising results in generating accurate and contextually relevant captions for diverse types of visual content[19], [20], [21] Additionally, the integration of hierarchical structures, contextual word embeddings, and attention mechanisms in encoder-decoder frameworks has further enhanced the performance of image captioning models[22], [23]. These advancements have led to improved feature extraction, word representations, and caption generation, ultimately contributing to the overall quality of generated captions. In summary, the paper "Deep Hierarchical Encoder-Decoder Network for Image Captioning" by contributes to the existing body of research by introducing a hierarchical approach to the encoder-decoder framework for image captioning. This approach aligns with the broader trend of leveraging deep learning methods, hierarchical structures, and attention mechanisms to enhance the quality and coherence of generated captions.

EXPERIMENTAL METHODOLOGY

The experimental methodology employed in this study entails extracting object features using the YOLOv4 model, complemented by incorporating image classification via CNN. This combination constitutes the foundational architecture of the image captioning Encoder-Decoder model. Additionally, our approach involves preprocessing steps to enhance feature extraction accuracy, followed by fine-tuning and hyperparameter optimization to improve the overall performance of the model. Through rigorous experimentation and analysis, we aim to elucidate the effectiveness of our proposed approach in generating accurate and contextually relevant image captions.

Datasets

Two primary datasets are employed for generating captions from images: MS COCO and Flickr8k. Flickr8k comprises real-life images sourced from the Flickr photo-sharing platform, each paired with five human-generated





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captions. Notably, the labels of the testing set in MS COCO are not publicly available. Table 1 presents a comparison between Flickr8k and MS COCO datasets.

Evolution matrix

We use different evaluation metrics which are widely used in the image captioning like BLEU, METEOR, ROUGE-L and CIDEr. Evolution metrics are commonly used for to similarity measure between a human generated caption and machine generated output; in the case of image captioning, the machine is automatically produced caption of the image. METEOR (Metric for Evaluation of Translation with Explicit Ordering) score to quantitatively assess the quality of machine-generated translations. METEOR incorporates oth precision and recall, considers word order information, and accounts for variations in word forms and synonyms, providing a comprehensive evaluation of translation quality. ROUGE-L (Recall-Oriented Understudy for Gisting Evaluation - Longest Common Subsequence) to assess the quality of machine-generated summaries. ROUGE-L emphasizes recall by considering the longest common subsequence between machine-generated and human reference summaries, offering a nuanced evaluation of summary coherence and content coverage.

Model

Our architecture employs an Encoder-Decoder design, integrating two distinct feature extraction methods for image captioning: a DenseNet CNN for image classification and a YOLOv4 object detection model. The outputs from these models are concatenated to form a comprehensive feature matrix, enhancing the information available to the language decoder for generating more precise descriptions.

Encoder

In our model used encoder – decoder framework. Two methods are used for feature extraction first Image classification using DenseNet[24] and Object detection method using YOLOv4[3]. Embedding method is used before apply input in our model then concate the features of both input text and the combination of image classification and object detection. LSTM and single fully connected layer used for language generation. Our model is simple, fast to train and generate caption.

Image Encoding

In our research, we leverage a pre-trained DenseNet CNN, which has been pretrained on the ImageNet dataset (Krizhevsky et al., 2012), to extract features from images. DenseNet, as proposed by Zhang et al. in 2019, specifically engineered to mitigate the vanishing gradient problem, this architecture plays a pivotal role in bolstering the accuracy of deep learning models across various tasks. By addressing the challenges associated with vanishing gradients, the DenseNet architecture significantly contributes to the stability and effectiveness of neural network training processes. This improvement in accuracy is particularly valuable in domains such as image classification, where subtle nuances and intricate patterns must be accurately captured and understood. Through rigorous experimentation and analysis, we aim to elucidate the profound impact of DenseNet on the performance of our deep learning models and explore avenues for further optimization and enhancement.

Among the various available architectures, we opt for DenseNet201 for its robust performance. It's important to note that our method primarily focuses on image classification rather than establishing relationships between classes and objects. The resulting feature output has a shape of 100×2048 . Additionally, we conduct thorough experimentation to validate the efficacy of our chosen architecture and explore potential optimizations to further improve performance. Through detailed analysis and evaluation, we aim to provide valuable insights into the effectiveness of our approach for feature extraction in image processing tasks. The object detection model employed in our approach is YOLOv4[3], chosen for its combination of accuracy and high-speed performance, rendering it well-suited for large datasets. Extracted features consist of a list of object features, with each object feature containing anchor box details. These anchor boxes encompass Xmax, Xmin, Ymax, Ymin, height, width, and a confidence rate ranging from 0 to 1. The Important factor is calculated using the following equation. [25] Importance Factor = Confidence Rate × Object Width × Object Height Our significance metric aims to equitably weigh objects and foreground elements of





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substantial size with high confidence levels. This metric assigns a greater weight to foreground objects of considerable size compared to background smaller ones, and it prioritizes objects with high confidence ratings over those with lower ones. Utilizing the quick sort algorithm, all objects are organized. A maximum of 292 objects is considered, each comprising seven attributes. For features with a length less than 2048, zero padding is applied, extending them to the required length.[25] In the process of determining the confidence score, YOLO employs a grid-based approach, partitioning the image into a grid and predicting B bounding boxes along with their respective confidence scores within each grid cell. This score indicates the model's confidence level regarding the presence of an object within the box and the accuracy of the box prediction. The evaluation of the object detection algorithm entails computing the Intersection over Union (IoU) metric between predicted and ground truth boxes, thereby quantifying their similarity based on their overlap. If a cell does not contain any object, its confidence score is designated as zero. The formula for calculating the confidence score is articulated as follows. Additionally, it's important to delve into the implications and significance of these calculations, considering factors such as the threshold for confidence scores and how they influence subsequent decisions in the object detection pipeline. Through meticulous examination and experimentation, we seek to refine our understanding of these concepts and optimize the performance of our object detection system C = Pr(Object) *IoU

Concatenation and embedding

To harness both the image classification and object detection features effectively, we introduce a concatenation process. Here, we append the output from the YOLOv4 subsystem as the final row to the output of stage 1. Consequently, the output shape of this stage becomes (101×2048) .

Language Decoder

To decode, we utilize LSTM for its efficiency in processing speed and minimal memory requirements. This LSTM framework generates captions sequentially, producing one word per time step. It relies on a context vector, the previous hidden state, and previously generated words to determine each word in the caption.

RESULT AND DISCUSSION

We utilized Python for crafting efficient code, incorporating various libraries such as TensorFlow, Keras, and NumPy. Additionally, we imported a pre-trained YOLOv4 model from the yolov4 library, trained on the MS COCO dataset. Our tests were performed on two commonly used datasets: MSCOCO and Flickr. The results of our proposed model are presented in Table 2. Unlike other models, our approach does not incorporate an attention mechanism for generating accurate captions. Our findings are compared with those of well-known papers employing different architectures and platforms. The results are generated within the sequence between the start and end.

CONCLUSION

Our research presents an Encoder-Decoder image captioning model integrating two feature extraction methods: an image classification CNN and an object detection module (YOLOv4), showcasing their efficacy. The importance factor, a pivotal parameter, prioritizes large foreground objects and those with high confidence, thereby elevating scores. Furthermore, we investigate or modify enhancements such as attention mechanisms, varied CNN architectures, fine-tuning, and hyperparameter tuning to enhance performance.

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Table 1: Comparison of different dataset

Datasets	No. of Images	Size	Validation split	Training split	Testing split
MS COCO	32800	Large	41k	83k	41k
Flickr8k	8992	small	1k	28k	1k

Table 2

Method	BLEU-1	BLEU-2	BLEU-3	BLEU-4	METEOR	ROUGE-L	CIDEr-D
SAA[26]	78.61	73.21	74.24	72.42	70.71	76.92	331.18
RTRMN[27]	70.47	72.42	70.71	81.17	-	70.71	356.43
Hard-attention[28]	45.21	72.48	73.21	72.42	46.31	76.92	361.65
mLSTM[29]	70.71	76.92	81.26	66.21	67.32	74.24	270.98
mRNN[29]	45.21	46.31	66.21	67.32	68.26	66.21	271.81
VLAD+RNN[30]	80.21	70.98	85.07	67.32	74.24	67.32	13.67
Proposed	75.25	74.89	73.63	72.89	75.06	81.26	335.89





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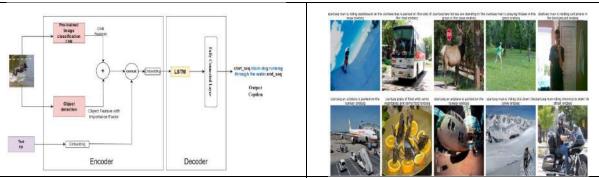
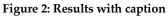


Figure 1: Overview of the proposed model for image captioning







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RESEARCH ARTICLE

Influence of Inorganic and Organic Nutrients on Growth and Yield of China Aster [Callistephus chinensis (L.) Nees] cv. Kamini

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ABSTRACT

The experiment entitled "Influence of inorganic and organic nutrients on growth and yield of China aster cv. Kamini" was carried out in a farmer's field at Nellur (village), Denkanikottai (Taluk), Krishnagiri district, Tamil Nadu during 2022 to 2023. The experiment was conducted by adopting inorganic nutrients (N, P and K) and various organic nutrients viz., Farmyard manure @ 5 t ha-1 and 10 t ha-1, Vermicompost @ 1.5 t ha-1 and 3 t ha-1, Coirpith compost @ 1.5 t ha-1 and 3 t ha-1 along with foliar application of Micronutrient mixture @ 0.5 per cent and 1 percent at 60 days after planting and then foliar application of Jeevamrutham @ 5 per cent at 30 and 90 days after planting. This experimental study was carried out in the Randomized Block Design (RBD) with three replications comprising thirteen treatments. Among the various vegetative parameters viz., plant height (cm), number of branches, number of leaves, leaf area (cm²), plant spread (cm), stem girth (cm), internodal length (cm), chlorophyll content index (CCI) and dry matter production (g plant-1) have been recorded maximum in the treatment T₁₃ (50 percent RDF + Vermicompost @ 3 t ha-1 + Coir pith compost @ 3 t ha-1 along with foliar application of micronutrient mixture @ 1 percent at 60 DAP and foliar application of Jeevamrutham @ 5 percent at 30 and 90 DAP) and yield parameters viz., number of flowers plant1, flower yield plant1 (g), flower yield plot1 (kg), flower yield hectare-1 (t ha-1) were performed best in the treatment T₁₃ with the application of 50 percent RDF + Vermicompost @ 3 t ha-1 + Coir pith compost @ 3 t ha-1 along with foliar application of micronutrient mixture @ 1 percent at 60 DAP and foliar application of Jeevamrutham @ 5 percent at 30 and 90 DAP. This was followed by the treatment T₁₂ consisting of 75 percent RDF+ Vermicompost @ 1.5 t ha⁻¹ + Coir pith





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compost @ 1.5 t ha⁻¹ along with foliar application of micronutrient mixture @ 0.5 percent at 60 DAP and foliar application of Jeevamrutham @ 5 percent at 30 and 90 DAP.

Keywords: China aster, Farmyard manure, Vermi compost, Coir pith, Micronutrient mixture, Jeevamrutham.

INTRODUCTION

Flowers play a significant role in our life right from birth to death. They are used at times of joy and sadness are part of our everyday lives. Flowers symbolize purity, beauty, peace and passion, they give us a unique way to share the love within people. Commercial floriculture is becoming important from an export angle. The liberalization of industrial and trade policies paved the way for the development of export-oriented production of cut flowers. It has been found that commercial floriculture has higher potential per unit area than most field crops and is, therefore, a lucrative business. Among the loose flowers China aster is one of the most important flower crops due to its varied range of colours and ease of cultivation. China aster [Callistephus chinensis L. Nees] is a member of the Asteraceae family. It is one of the most important commercial annual flower crops grown in most parts of the world. Among annual flowers, it ranks third, next to the chrysanthemum and marigold. Application of inorganic amendments viz., nitrogen, phosphorus and potassium to supply enough of these elements for the rapid growth of crop plants during their early growth and economic production. Application of organic amendments like farmyard manure, vermicompost and coir pith compost as organic nutrients improves the soil texture, soil porosity, and water retention capacity and maintains a congenial microbial population, which increases soil nutrition. micronutrients must be taken up by the plants supplemented through foliar spray might basically enhance photosynthetic and other metabolic activities related to cell division and elongation (Hatwaret al., 2003). Jeevamrutham is a liquid organic manure and is considered to be an excellent source of natural carbon, biomass, nitrogen, phosphorous, potassium and other micronutrients required for the crop. In this study attempt is made to find out the influence of inorganic and organic nutrients on performance of China aster and find out the best treatment combination for maximizing growth and yield of China aster.

MATERIALS AND METHODS

The present investigation on "Influence of inorganic and organic nutrients on growth, flowering, yield and quality of China aster [Callistephus chinensis (L.) Nees] cv. Kamini" was carried out in a farmer's field at Nellur village, Denkanikottai taluk in Krishnagiri district during the year 2022–2023. The experiment was laid out in randomized block design with a plant spacing of about 30 cm x 30 cm containing 9 plants experimental per plot. The experiment conducted by using different inorganic fertilizers viz., nitrogen, phosphorus and potassium and organic manures viz., farmyard manure, vermicompost, coir pith compost and foliar application of micronutrient mixture and jeevamrutham. The observations are recorded on the selected five plants for a treatment in each replication and the mean data is statistically analyzed. The plots were kept free from weeds by periodic hand weeding. Earthing up operations was done whenever found necessary. Pests and diseases were controlled periodically during the entire crop period. The data were subjected to statistical analysis as suggested by Panse and Sukhatme (1985). Data of three replications were tabulated and recorded. The treatment details are shown in the Table 1.

RESULT AND DISCUSSION

Application of inorganic and organic nutrients significantly influenced the growth and yield parameters. Plant nutrition is of unique importance and is known to play a decisive role in the growth and all-round development of the crop. Nitrogen, phosphorus, potassium of the key nutrient elements for enhancing for productivity of plants. The





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use of organic constituents increases productivity, improves soil fertility and reduces the use of hazardous fertilizers. Nutrient management techniques in the field after planting through integrated approaches have claimed to be a beneficial method of improving crop growth, physiology, flowering and yield. Organic nutrients *viz.*, farmyard manure, vermicompost and coir pith compost are important organic resources that contain plant nutrients in their available form. It maintains soil productivity better than inorganic fertilizers. There are various technologies to boost up the productivity but nutrient management has got greater significance in maximizing the yield of the crop. Therefore, the use of both inorganic and organic nutrients in appropriate quantities are very useful for sustainable flower crop productivity. The result of the precent study entitled "Influence of inorganic and organic nutrients on growth and yield of China aster [*Callistephus chinensis* (L.) Nees.] cv. Kamini" are discussed hereunder. The data and their results are present in table (2 and 3) on growth parameters *viz.*, plant height (cm), number of branches, number of leaves, leaf area (cm²), plant spread (cm), stem girth (cm), internodal length (cm), chlorophyll content index (CCI) and dry matter production (g plant¹¹) and yield parameters *viz.*, Number of flowers per plant, flower yield plant¹¹ (g plant¹¹), flower yield plot¹ (kg plant¹), flower yield hectare¹ (t ha-¹) are tabulated in table 4.

Vegetative parameters

Vegetative parameters are very important as they determine the yield attributes of any crop. Application of various nutrients significantly influenced performance of China aster on its vegetative parameters. Growth is a multidimensional web of many parameters. The effect of treatments concluded that the treatment T₁₃ with the application of 50 percent RDF combined with Vermicompost @ 3 t ha-1 and Coir pith compost @ 3 t ha-1 along with foliar application of micronutrient mixture @ 1 percent at 60 DAP and foliar application of Jeevamrutham @ 5 percent at 30 and 90 DAP performed the best in all the growth attributes, which recorded the highest values in plant height (24.11 cm, 54.15 cm and 70.12 cm on 30, 60 and 90 DAP respectively), number of branches (11.85, 16.96 and 24.82 on 30, 60 and 90 DAP respectively) and number of leaves (18.17, 90.89 and 164.10 on 30, 60 and 90 DAP respectively), leaf area (36.72 cm²), plant spread (32.96 cm in North-South direction and 27.11 cm in East-West direction), stem girth (3.84 cm) internodal length (4.58 cm) are noted. The increase in growth parameters viz., plant height (cm), number of branches, number of leaves, plant spread (cm) and stem girth (cm) might be due to the application of the optimum dose of both inorganic and organic fertilizers. The increase in vegetative growth is also due to the adequate availability of nitrogen content in vermicompost and the application of 50 percent of the recommended dose of fertilizer, which leads to an increase in cell number and size. Coir pith compost plays a vital role in providing good aeration to plants in order to sustain the growth and development of shoots. All these vegetative growths of China aster plants grown in this nutrient combination resemble greater carbohydrate accumulation, which in turn increased photosynthesis and simultaneously maximized the growth of roots and shoots. An increase in the number of leaves causes the accumulation of greater photosynthesis, leading to better growth parameters.

Leaves are the important functional units for photosynthesis, which greatly influence the growth and flower yield of any crop. This was in concurrence with the findings of Bharani Vijay and Sendhilnathan (2019) in Gomphrena, Sailaja *et al.* (2013) in China aster and Hawa *et al.* (2021) in Chrysanthemum. The increase in growth parameters was due to the foliar application of a micro nutrient mixture at an appropriate time, which might have improved the growth and development of China aster. In small concentration, micronutrient application also enhances photosynthesis and other metabolic activities related to cell division and elongation. This was in concurrence with the findings of Madhubala and Sendhilnathan (2019) in Rose and Mukeshkumar *et al.* (2018) in Gerbera. The differential changes among various treatments are shown in fig (1) and fig (2). The highest chlorophyll content of leaves (69.82CCI) and dry matter production (78.49 g plant¹) were observed in treatment T₁₃. The increase in chlorophyll content and dry matter production is obtained the treatment T₁₃ its due to the absorption of various nutrients through plant roots and translocated it to the shoots and other plant parts which eventually enhancing all the physiological activities in the plant. The reason for increased chlorophyll content and dry matter production might be due to diversion of adequate photosynthesis nutrients such as iron and nitrogen to the site of photosynthesis for enhancing the chlorophyll content by the coupled effect of macro and micro nutrients. Furthermore, foliar application of nutrients facilitates greater uptake of nutrients which leads to the effective conversion of chlorophyll content by its nitrogen fixing capacity and





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its capacity to synthesize growth hormones like GA₃, cytokinin etc. Meanwhile, vermicompost and coir pith compost combined with an appropriate quantity of recommended dose of fertilizer, increase the net photosynthetic rate due to the high content of chlorophyll and the improved chloroplast ultrastructure. The increase in dry matter may be due to the higher rate of supply of photosynthates from vegetative parts to the reproductive parts, which subsequently might have resulted in higher dry matter accumulation. Application of a 1 percent micronutrient mixture at the appropriate time also plays an important role in increasing the high content of chlorophyll in the plant. At the same time, foliar application of Jeevamrutham at 5 percent at 30 and 90 DAP at different stages of growth also maximized dry matter production. These results were in accordance with the results of Singh *et al.* (2015) in Marigold, Nagdeve*et al.* (2020) in Chrysanthemum and Mahadik *et al.* (2017) in Chrysanthemum.

Yield parameters

In the present investigation, the data on yield parameters viz., number of flowers plant 1 (36.17), flower yield plant 1 (138.96 g), flower yield plot (3.07 kg) and flower yield hectare (12.43 t ha) was produced by the plants in treatment T₁₃ with the application of 50 percent RDF combined with Vermicopost @ 3 t ha⁻¹ and Coirpith compost @ 3 t ha⁻¹ results in maximizing yield parameters. Along with this, the application of micronutrients and Jeevamrutham as a foliar spray influenced the maximum yield. This increased number of flowers might be due to the production of a greater number of branches at an early stage, which promote sufficient time to accumulate more carbohydrates for a proper flower bud, thereby inducing a greater number of auxiliary shoots, resulting in a greater number of flowers. A similar finding was reported by Jena et al., (2021) and Nagdeveet al., (2020) in Chrysanthemum. Increasing in yield might be due to the application of Vermicompost and Coir pith compost along with 50 percent of recommended dose of inorganic nutrients enhanced vigorous growth and this vermicompost and coir pith compost act as versatile natural bio reactors for effective recycling of nontoxic organic waste to the soil and thereby it is used as an alternative source of nutrition in crop production for enhancing plant root initiation, improvement in root biomass, plant growth enhancement, increase in crop yield and plant productivity. Especially coir pith compost act as a good water holding capacity which it holds water in the inner matrices of coir pith was found to be retained for a long period of time and it also provides balanced water nutrients and abundant oxygen supply for healthy growth of a plant. In addition to this application of a micronutrient mixture at appropriate time enhanced growth in different ways by increasing more number of branches and thereby increasing the yield. A similar finding was reported by Sendhilnathanet al.,(2019) in Rose. Simultaneously, foliar application of Jeevamrutham in optimum quantity at right time enhance growth by adding active substances such as polysaccharides, proteins, amino acids and glycosides and it also increases nitrogen fixation and phosphorus solubilization, which in turn leads to increasing flower yield. Similar findings were reported by Praveen et al. (2020) in Rose, Manoj Kumar Paikraet al., (2022) in African marigold.

CONCLUSION

Based on the present investigation it can be concluded that the treatment combination of 50 percent RDF + Vermicompost @ 3 t ha⁻¹ + Coir pith compost @ 3 t ha⁻¹ along with foliar application of micronutrient mixture @ 1 percent at 60 DAP and foliar application of Jeevamrutham @ 5 percent at 30 and 90 DAP is best suited to grow China aster [*Callistephus chinensis* (L.) Nees] in open field condition to achieve good growth and yield of the crop.

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Table 1: Treatment details of the experiment

-	•
T_1	Control - 100 % RDF (180: 60: 60 kg of NPK ha-1)
T ₂	75 % RDF + Farm yard manure @ 5 t ha ⁻¹
Т3	75 % RDF + Vermicompost @ 1.5 t ha-1
T ₄	50 % RDF + Farm yard manure @ 10 t ha-1
T 5	50 % RDF+ Vermicompost @ 3 t ha-1
T ₆	75 % RDF + Farm yard manure @ 5 t ha-1 + Coir pith compost @ 1.5 t ha-1
T 7	50 % RDF+ Farm yard manure @ 10 t ha-1 + Coir pith compost @ 3 t ha-1
T ₈	75 % RDF+ Vermicompost @ 1.5 t ha-1 + Coir pith compost @ 1.5 t ha-1
T 9	50 % RDF+ Vermicompost @ 3 t ha-1 + Coir pith compost @ 3 t ha-1
T ₁₀	75 % RDF + Farm yard manure @ 5 t ha-1 + Coir pith compost @ 1.5 t ha-1 + foliar application of Micronutrient
110	mixture @ 0.5 % at 60 DAP + Jeevamrutham @ 5 % at 30 and 90 DAP
T11	50 % RDF + Farm yard manure @ 10 t ha-1 + Coir pith compost @ 3 t ha-1 + foliar application of Micronutrient
111	mixture @ 1 % at 60 DAP + Jeevamrutham @ 5 % at 30 and 90 DAP
T ₁₂	75 % RDF+ Vermicompost @ 1.5 t ha-1 + Coir pith compost @ 1.5 t ha-1 + foliar application of Micronutrient
112	mixture @ 0.5 % at 60 DAP + Jeevamrutham @ 5 % at 30 and 90 DAP
T ₁₃	50 % RDF + Vermicompost @ 3 t ha-1 + Coir pith compost @ 3 t ha-1 + foliar application of Micronutrient mixture
113	@ 1 % at 60 DAP + Jeevamrutham @ 5 % at 30 and 90 DAP





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Table 2: Influence of inorganic and organic nutrients on plant height (cm), Number of branches plant⁻¹, Number of leaves plant⁻¹ of China Aster [*Callistephus chinensis* (L.) Nees]

or leaves plan	Plant height (cm)			Number of branches plant ⁻¹			Number of leaves plant-1		
Treatments	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
T ₁	14.67	32.22	41.07	5.72	7.14	10.45	10.85	32.81	76.87
T ₂	15.74	34.74	44.12	7.08	8.93	13.65	11.57	40.23	89.86
T ₃	16.63	36.80	46.88	7.55	9.75	14.48	12.24	45.69	98.02
T ₄	17.49	38.87	49.66	8.06	10.59	15.93	12.92	51.14	105.97
T 5	18.35	40.93	52.42	8.53	11.41	17.05	13.58	56.53	113.96
T ₆	19.23	43.01	55.18	9.02	12.26	18.19	14.27	62.01	122.03
T ₇	20.34	45.42	58.50	9.70	13.37	19.97	15.24	68.27	131.14
T ₈	19.48	43.36	55.74	9.21	12.54	18.85	14.56	62.84	122.97
T9	21.22	47.48	61.26	10.17	14.22	21.11	15.91	73.69	139.12
T ₁₀	22.09	49.53	64.03	10.67	15.04	22.24	16.59	79.13	147.07
T ₁₁	22.36	49.99	64.56	10.86	15.30	22.57	16.82	79.98	147.96
T ₁₂	23.22	52.09	67.34	11.36	16.12	23.68	17.49	85.47	156.14
T ₁₃	24.11	54.15	70.12	11.85	16.96	24.82	18.17	90.89	164.11
S.E.D	0.40	0.91	1.17	0.20	0.27	0.41	0.30	1.47	2.70
C.D (p=0.05)	0.83	1.87	2.42	0.40	0.57	0.84	0.63	3.03	5.58

Table 3: Influence of inorganic and organic nutrients on Leaf area (cm²), plant spread (cm), Stem girth (cm), Internodal length (cm), Chlorophyll content index (CCI), Dry matter production (g plant¹) of China Aster [Callistephus chinensis (L.) Nees]

	Leaf	plant spre	ead (cm)	Stem	Internodal	Chlorophyll	Dry matter
Treatments	area (cm²)	North- South	East- West	girth (cm)	length (cm)	content index (CCI)	production (g plant¹)
T ₁	15.89	19.76	16.55	1.73	2.47	43.81	48.36
T ₂	18.40	21.16	17.73	2.02	2.72	46.08	52.43
T ₃	20.35	22.38	18.71	2.21	2.90	48.59	55.24
T ₄	22.27	23.61	19.68	2.38	3.09	51.16	58.02
T ₅	24.21	24.82	20.67	2.58	3.29	53.68	60.78
T ₆	26.12	26.07	21.64	2.75	3.48	56.24	63.54
T ₇	28.61	27.71	23.02	3.02	3.74	59.32	66.75
T ₈	26.67	26.47	21.98	2.83	3.55	56.79	63.97
T9	30.54	28.92	24.03	3.21	3.92	61.85	69.53





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T ₁₀	32.47	30.14	25.01	3.39	4.11	64.36	72.29
T ₁₁	32.86	39.49	25.15	3.47	4.19	64.71	72.98
T ₁₂	34.80	31.72	16.12	3.66	4.38	67.28	75.74
T ₁₃	36.72	32.96	27.11	3.84	4.58	69.82	78.49
S.E.D	0.60	0.55	0.45	0.06	0.07	1.21	1.32
C.D (p=0.05)	1.23	1.14	0.94	0.13	0.15	2.50	2.74

Table 4: Influence of inorganic and organic nutrients on Number of flowers per plant, Flower yield plant⁻¹ (g plant⁻¹), Flower yield plot⁻¹ (kg plot⁻¹), Flower yield hectare⁻¹ (t ha⁻¹) of China Aster [Callistephus chinensis (L.) Nees]

Tassianada	Non-lon-Colombia al-	Flower yield plant ¹	Flower yield plot-1	Flower yield
Treatments	Number of flowers plant-1	(g plant-1)	(kg plot-1)	hectare-1 (t ha-1)
T ₁	19.41	28.27	1.02	3.86
T ₂	21.97	36.88	1.71	5.94
T ₃	23.44	43.94	1.84	6.88
T ₄	24.73	51.66	2.01	7.39
T 5	26.07	60.82	2.13	7.92
T ₆	27.36	71.05	2.26	8.47
T ₇	29.73	86.29	2.45	9.18
T ₈	27.94	74.83	2.31	8.69
T9	31.49	97.03	2.59	9.71
T ₁₀	33.04	110.01	2.74	10.22
T ₁₁	33.59	113.54	2.79	10.61
T ₁₂	34.88	124.61	2.92	11.84
T ₁₃	36.17	138.96	3.07	12.43
S.E.D	0.60	2.17	0.05	0.20
C.D (p=0.05)	1.25	4.48	0.10	0.41





RESEARCH ARTICLE

Eco-Friendly Synthesis of Magnesium Oxide Nanoparticles using *Crocus* sativus Extraction and their Antioxidant and Antibacterial Activity

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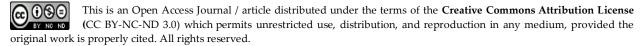
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ABSTRACT

The use of nanomaterials for environmental remediation represents an ambitious and innovative solution, which guarantees a fast and efficient removal of pollutants from contaminated sites. The present work reports the ecological synthesis of magnesium oxide nanoparticles using saffron (*Crocus sativus*) flower extract. UV, FTIR and SEM were used to evaluate the properties of green-synthesized MgO nanoparticles. However, the synthesized MgO NPs revealed the antioxidant activity against the free radical scavenging and antibacterial activity against two pathogenic bacteria. The green synthesis of MgO NPs could be used in pollution control, and it will be a breakthrough in the development of more environmentally friendly, low-cost, energy-efficient, sustainable, and innovative nanostructured materials.

Keywords: crocus sativus, UV, FTIR, SEM, antioxidant, antibacterial





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INTRODUCTION

Nanoparticles are gaining attention in the research is primarily focused on materials science, energy science, medicine, and biotechnology, with applications in ceramics, catalysis, electronics, coatings, petrochemical products, metallic ceramics, and fiber boards.. Nanoparticles are extremely useful in biological and medical applications such as sensors, medical devices, medication administration, bacteriostatics, dye degradation, and DNA labeling due to their high surface-volume ratio and compact size. Nanostructured materials can be synthesized via physical, chemical, and biological techniques (Rajeshwari B et al 2023). Chemical synthesis methods like Precipitation, pyrolysis, micelle, hydrothermal, and sol-gel pose a risk to ecology and the environment. Green synthesis, which uses biological raw materials like microorganisms, algae, and plants, aims to minimize these negative effects. Green synthesis is a cost-effective, non-toxic, and non-hazardous process for producing simple metal oxide nanoparticles. These nanoparticles have various applications, including anti-inflammatory, antibacterial, drug delivery, bioactivity, tumor targeting, anticancer, and bio-absorption. They are additionally employed in semiconductors, magnetic devices, photocatalysts, microelectronic devices, corrosion-resistant coatings, electrocatalysts, and powder metallurgy. Different parts of plant extracts are utilized for material preparation. The extracts, rich in phytochemicals like flavonoids, alkaloids, and phenolics, are formed when the plant extract reacts with metal salts, resulting in nanoparticles of various sizes and shapes (Muralidhara H. B., et al. 2021). Nanoparticles and metal oxide nanoparticles can be put together from various plant extracts, but leaves are the preferred source for metabolites due to their non-pathogenic nature and faster reduction rate compared to bacteria or algae. Flower extracts are safe and non-pathogenic, making them a preferred resource for metabolites Plant extracts contain phytochemicals that help to reduce metal ions and oxides, resulting in metal nanoparticles. Functional amino groups reduce metal oxide, and oxygen or degrading phytochemicals further reduce metal ions. Plant extracts incorporate phytochemicals, proteins, and starch, which generate metal nanoparticles due to electrostatic attraction, stabilizing the particles and facilitating metal oxide formation. Phenolic substances having carboxyl and hydroxyl groups inhibit superoxide, a reactive oxygen species. This process helps to maintain the stability of the plant's composition (S. F., Faruque M., et al. 2022).

ZnO, magnesium oxide, and TiO are metal oxides with unique thermal properties, offering stability, wide energy bandgap, and high melting point, making them suitable for various applications in various fields. The green method is being explored for sustainable production of nanomaterials, with potential applications in creating new functional components, highlighting the importance of biosynthesis in this process (Ali J., et al. (2019). Biological methods that allow the production of MgO NPs using plant resources are not yet widely used. The biological components work as a reduction agent and a cap in the eco-friendly production of nanoparticles, eliminating the need for excessive energy, hazardous chemicals, extreme pressures, and so on. Biological synthesis allows for the large-scale production of nanoparticles. Every day, the nanoscience renaissance grows fiercer. Nanoscience is the development of novel materials on the nanoscale (1-100 nanometers). The processed materials have unique qualities that are not present in bulk materials (Soliman, A.M et al 2021). Shape, size, integration, charge distribution on the surface, chemical stability, catalytic activity, and tiny proportions to a big surface area are some of these distinctive characteristics. (Rajeswaran, S. et al 2020) The aforementioned characteristics make them suitable for a wide range of biotechnological and biological applications. The nanomaterial compounds were synthesized utilizing multiple methodologies, including physical, chemical, and biological methods. (Mahmoudi, F et al 2021). Physical methods were created under severe working conditions and utilized substantial energy via complex experimental instruments. (Goodarzi, M. et al 2018) While chemical synthesis involved the use of harmful organic solvents and toxic reducing agents, it also produced undesired byproducts with significant environmental consequences. As a result, the researchers' focus is devoted toward biological strategies to overcoming or preventing the difficulties connected with chemical and physical reactions. (Prasanth, R. et al 2019). Crocus sativus for many years, this spice, often known as saffron, has been utilized by ancient traditional and folk therapies. Today, a plethora of experimental evidence reinforced the clinical importance and safety of its dried red-orange stigmas and essential bioconstituents (crocin, crocetin, dimethylcrocetin, and safranal), as well as the possibility and wide variety of its by-products (petals, anthers) to be used as a food supplement or therapeutic/industrial agent.. (Simone Carradori et al 2021). Crocus





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sativus is a plant with petals from the Iridaceae family which is typically referred to as saffron. Crocus sativus is a perennial herb that flourishes in many countries with moderate to dry temperatures, especially Iran, India, Greece, Morocco, Spain, Italy, Turkey, Pakistan, Azerbaijan, China, and Egypt. Saffron is frequently used as a spice yet culinary colorant, and less frequently as a textile dye or olfactory. (Marjan Nassiri-Asl *et al* 2015). Saffron encompasses around 150 volatile and aroma-producing chemicals. It contains numerous nonvolatile active components, including carotenoids as zeaxanthin, lycopene, and α - and β -carotenes. Saffron has significant medical uses. (R. Vijayakumar *et al* 2011).

ANALYSIS OF CROCUS SATIVUS FLOWER EXTRACT is to evaluate the

- 1. Collection of *Crocus sativus flower*
- 2. Preparation of magnesium oxide nanoparticles
- 3. Spectrum analysis of nanoparticles:
- 4. Ultraviolet–visible spectroscopy (UV)
- 5. Fourier transform infrared spectroscopy (FTIR) and
- 6. Scanning Electron microscopy (SEM)
- 7. Antioxidant activity
- 8. Antibacterial activity

MATERIALS AND METHODS

COLLECTION OF CROCUS SATIVUS FLOWER

Crocus sativus flower were collected from jasmar enterprise, Singapore (origin of Spain). The flowers were soaked with double distilled water for 24hours. The extract of Crocus sativus flower was prepared using 100 ml distilled water and 10g of saffron. The obtained extract was filtered using Whatmann No1 filter paper and it stored at 4°C for further use

Preparation method

They are two methods

- ✓ Chemical synthesis of MgO nanoparticles
- ✓ Biosynthesis of MgO nanoparticles

Chemical synthesis MgO nanoparticles

Magnesium nitrate, Sodium hydroxide and Starch are the chemicals purchased from Merck. Magnesium oxide nanoparticles were prepared by wet chemical method using magnesium nitrate and sodium hydroxide as precursors and soluble starch as stabilizing agent. Starch act as a stabilizing agent and prevents the agglomeration of nanoparticles. Starch (0.1 % concentration) solution was prepared in 100 ml of distilled water and Magnesium nitrate 12.83 g (0.1 M) was added to the above solution. Then the solution was kept under constant stirring using magnetic stirrer for complete dissolution of contents. After complete dissolution, 4g (0.2 M) sodium hydroxide solution (25 ml) was added in drops along the sides of the container under constant stirring for 2 hours and allowed to settle for 24 hours. The supernatant liquid was then discarded carefully and the remaining solution was centrifuged 4,500rpm for 15 minutes. Centrifugate was washed three times using distilled water to remove the by-products and the excessive starch that bound with the nanoparticles. The nanoparticles of magnesium hydroxide were placed in furnace at 300° C, 500° C and 700° C for 4 hours. During this process, conversion of magnesium hydroxide into magnesium oxide takes place. The following reaction explains the formation of magnesium oxide nanoparticles. Mg (NO3)2 .6H2O + 2 NaOH \rightarrow Mg (OH) 2 + 2NaNO3 Mg (OH) 2 MgO +H2O





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Synthesis of MgO nanoparticles

10g of Magnesium nitrate was dissolved in 100 ml distilled water and it was allowed to boil at 60°C for 20 min. Then, the 50ml of *Crocus sativus* flower extract was added to 100ml of magnesium nitrate solution and it was kept at magnetic stirred for 3 hours. Change in color & it indicates reduction and reduces MgO nanoparticles. It was purified by centrifugation (4500 rpm) for15mins .Next; the obtained precipitate was annealed at 400°C-500°C for 3 hours. After the annealing process fine powder was obtained & stored at room temperature for further studies.

Characterization studies and activities of magnesium oxide nanoparticles

UV- Visible spectrum for synthesized nanoparticles

The sample was measured for its maximum absorbance using UV -Visible spectrometer. The optical property of MgO nanoparticles was analyzed via ultraviolet and visible absorption spectroscopy in the range of 200-800nm.peak obtained at 271.2 nm

FTIR analysis for synthesized nanoparticles

The FTIR spectrum was taken in the mid -IR region of 400 - 4000 cm. The spectrum was recorded using ATR (Attenuated total reflectance) technique. The dried sample was mixed with the KBr (1:200) crystal, and the spectrum was recorded in the transmittance mode

2,2-DIPHENYL-1-PICRYLHYDRAZYL FREE RADICAL SCAVENGING ACTIVITY ASSAY BY BRAND-WILLIAMS et al. (1995)

The extracts were prepared in concentrations of 20, 40, 60, 80, & 100 μ g/mL for this assay. First, 3 mL of extract of each concentration was mixed with 1 mL of the 0.1 mmol/L DPPH solution prepared in methanol. Next, the tubes were incubated in the dark at room temperature for 30 min and then read at 517 nm using a UV-VIS spectrophotometer. Solvent without extract was used as a negative control and AA was used as a positive control. The effect of antioxidant capacity was observed as the color change of purple DPPH to yellow/light-yellow and % inhibition values of each extract were calculated using the following equation:

Inhibition (%) = $[(A control - A blank) - (As ample - A blank)] \times 100/(A control - A blank),$

Where a control is the absorbance of the negative control and a sample is the absorbance of AA or extracts. Inhibitory concentration (IC50) values were calculated with inhibition rates using a four-parameter logistic regression model after sigmoidal curves were plotted. Each of the standards and the samples were measured in triplicate and mean values were used for the calculations.

Antibacterial activity by Agar Well Diffusion

Agar well diffusion method was trailed for antibacterial activity. The Muller Hinton agar was prepared, poured on Petri plates and allowed to solidify. After solidification, 0.1 ml of standardized microbial inoculums suspension was poured and uniformly spread. The excess inoculum was drained and the plates were allowed to day for 5 minutes. After drying, sample was placed on the plates with sterile pipette. Biosynthesized sample (50 μ l, 100 μ l, and 150 μ l, 200 μ l) were used as the positive control and the DMSO (5%) was used as a blind control. Finally, the inoculated plates were incubated at 37°C for 24 hours. The zone of inhibition was observed and measured in millimeters. This experiment was repeated for two times.

RESULT AND DISCUSSION

Phytochemical analysis of aquesous extract of crocus sativus

The Crocus sativus aqueous extract was subjected to a preliminary phytochemical analysis that revealed the presence of carbohydrate, alkaloid, flavonoid, steroid, terpenoid, tannin, quinine, saponin, phenol are presented but glycoside was absent.





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UV - VIS SPECTROSCOPY

The synthesized magnesium Oxide nanoparticle illuminates the optical properties by UV-Visible Spectrum and photoluminescence spectroscopy. The peak of maximum absorption was visualized approximately at 271.2nm.

FTIR ANALYSIS

The Fourier transform infrared spectroscopy analysis documented the chemical compounds and its coordination in the prepared MgO nanoparticle. The IR spectra of sample of particles typically depend on the particle size and shape shows the FT-IR spectra of the generated MgO nanoparticles. The peak at 3700 cm-1, which is most likely generated by ambient moisture, indicates the presence of –OH residue.

SEM ANALYSIS

The dimensions and form of magnesium oxide nanoparticles have been detected and exposed via SEM assessment. The size of the produced magnesium oxide nanoparticles was found to be 185.2 nm. In this present work, the obtained magnesium oxide nanoparticles were appear in rod shape

In-vitro Antioxidant Activity of MgO nanoparticle:

The antioxidant potential of bioactive compounds can be examined using the stable radical DPPH. By measuring the absorbance of the DPPH radical in the sample at 517 nm, crocus sativus flower extract antioxidant activity was determined using ascorbic acid as a control. In terms of DPPH antioxidant activity, crocus sativus extract at 50 µg/ ml has a scavenging capacity of about 100% compared to conventional ascorbic acid's 90%.

In-vitro Antibacterial Activity of Mgo nanoparticle:

The impregnation method was used to evaluate the antibacterial activity of magnesium oxide nanoparticles against bacteria Bacillus subtitles and E. coli. The zone of inhibition for gram-positive bacteria was wider than that for gram-negative bacteria. Both gram-positive and gram-negative bacteria were susceptible to the antibacterial activity of the synthesized magnesium oxide nanoparticles. However, the antibacterial effect was higher against gram-positive bacteria, with inhibition zones of 30 mm and 19 mm, respectively. The composition of gram-positive bacteria's cell walls differs significantly, with gram-positive bacteria lacking an outer layer and a thick peptidoglycan coating.

CONCLUSION

It can be concluded that the results showed that the preliminary phytochemical analysis of the aqueous flower extract of Crocus sativus demonstrated the absence of glycoside, and the presence of carbohydrate, alkaloid, flavonoid, steroid, terpenoid, tannin, quinine, saponin, and phenol respectively. Further analysis was to synthesized magnesium oxide nanoparticles prepared by biological method. The flower extract contains organic compounds that act as a reducing and stabilising agent. Many methods, including UV-Vis, FT-IR and SEM were used to characterize the produced MgO NPs. The available literature supports this statement was synthesized of magnesium oxide nanoparticles was prepared for further analysis UV - visible spectroscopy confirmed the characteristic absorption peaks at 271.2nm and FTIR spectroscopic analysis given a detailed information about the chemical compounds present in the MgO NPs and SEM analysis of MgO NPs revealed their size and shape. The results of the DPPH radical scavenging activity showed that the Crocus sativus aqueous extract had IC (70) ranges and control ascorbic acid IC (62) ranges respectively.





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Table -1 Phytochcemical analysis; Symbol (+) indicates positive and (-) indicates negative

S.NO	PHYTOCHEMICAL	AQUEOUS EXTRACT
1.	Carbohydrate	+
2.	Alkaloid	+
3.	Flavanoid	+
4.	Steroid	+
5.	Terpenoid	+
6.	Tannin	+
7.	Quinone	+
8.	Saponin	+
9.	Glycoside	-
10.	Phenol	+

Table: 2 presented functional groups

Characteristic absorption(cm-1)	Appearance	Group	Compound Class
3700.16	Medium	O-H Stretching	alcohol
3416.16	Medium	N-H Stretching	aliphatic primary amine
2426.62	Strong	O-H Stretching	carboxylic acid





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1631.64	Medium	C=C Stretching	alkene
1384.13	Medium	C-H Stretching	alkane
1017.83	Medium	C-N Stretching	amine
839.51	Medium	C=C Bending	alkene
601.01	Strong	C-Br Stretching	halo Compound

Table: 3 zone of inhibition (mm in dm)

	_	Zone o	f inhibitio	Blind control		
S.NO	Bacteria	50μL	100μL	150μL	PC	(5% DMSO)
1	Bacillus subtillis	30	32	34	20	No zone
2	Escherichia coli	19	23	26	19	No zone



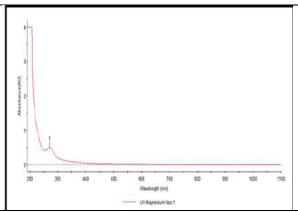


Figure:1 phytochemical analysis

Figure: 2 UV-Visible Spectroscopy

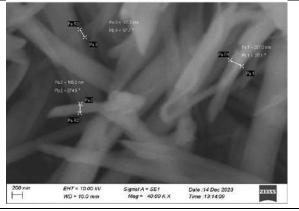


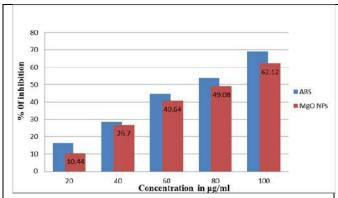
Figure: 3 FTIR Analysis

Figure: 4 SEM Analysis





Subhashini and Fernandus Durai



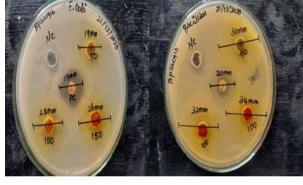


Figure:5 Antioxidant activity assay by DPPH method

Figure: 6 Antibacterial activity by agar well diffusion method





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RESEARCH ARTICLE

The Perception of Non-Prime Pseudo Intrinsic on Bi-Magic Interval Valued Fuzzy Graphs

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ABSTRACT

Fuzzy-graph assemblies are more useful than graph assemblies for the reason that they deal with the uncertainty and ambiguity of many real-world phenomena. In this paper, we commenced the concept of non-prime pseudo intrinsic on Interval Valued Fuzzy Bi-Magic Graphs (IVFBMGs) using its composite strength. We reviewed these concepts in complete graph, Arrow graph, cycle graph, Gem graph and Butterfly graph.

Keywords: Interval Valued Fuzzy Graphs, Bi-Magic Intrinsic constant, mock Constant, prime strength, prime pseudo IVBMFG and composite pseudo IVFBMG.

INTRODUCTION

Graph theory is a very important tool to represent many real-world problems. Nowadays, graphs do not represent all the systems properly due to the uncertainty or haziness of the parameters of systems. If the relations among accounts are to be measured as good or bad according to the frequency of contacts among the accounts, fuzziness should be added to representation. This and many other problems motivated to define fuzzy graphs. A fuzzy graph contains many properties like crisp graph due to generalization of crisp graphs, but it diverges at many places. A crisp graph G is an order pair of vertex-set V and edge set E such that $E \subseteq V \times V$. In addition, v = |V| is said to order and e = |E|is called size of the graph G respectively. In a crisp graph, a bijective function $\rho: V \cup E \to N$ that produced a unique positive integer (To each vertex and/or edge) is called a labelling [16]. Enomoto, H et al introduced the notion of magic graph that the labels vertices and edges are natural numbers from 1 to |V| +|E| such that sum of the labels of vertices and the edge between them must be constant in entire graph [8]. Numerous other authors have explored





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diverse types of different magic graphs [1], [9] & [15].. These labelling are currently referred to as either edge magic labelling or edge-magic total labelling. Fuzzy graphs are generalization of graphs. In graphs two vertices are either related or not related to each other. Mathematically, the degree of relationship is either 0 or 1. In fuzzy graphs, the degree of relationship takes values from [0, 1]. A fuzzy graph has ability to solve uncertain problems in a wide range of fields. In this paper we have developed the concept of interval valued fuzzy non-prime pseudo intrinsic graphs using its composite strength. Also, we discussed the non-prime double pseudo intrinsic bi-magic graphs. Those graphs are developed by the nature of mock constant and intrinsic constant.

PRELIMINARIES

Definition 2.1.

A **fuzzy graph** G=(A, B) is a pair of functions A:V \rightarrow [0, 1] and B:VxV \rightarrow [0, 1] where for all u, v \in V, we have B(u, v) \leq Min{A(u), A(v)}

Definition 2.2.

By an **interval-valued fuzzy graph** G of a graph G*, we mean a pair G = (A, B), where $A = [\mu_A^-, \mu_A^+]$ is an interval-valued fuzzy set on V and $B = [\mu_B^-, \mu_B^+]$ is an interval-valued fuzzy relation on E such that $\mu_B^-(xy) \le \min(\mu_A^-(x), \mu_A^-(y))$,

 $\mu_B^+(xy) \le \min(\mu_B^+(x), \mu_B^+(y))$, for all $xy \in E$. Throughout this paper, G* is a crisp graph, and G is an interval-valued fuzzy graph.

Definition 2.3.

An interval $[\mu - \delta, \mu + \delta]$ is said to be an δ -neighborhood of any membership value for any δ satisfying the following conditions.

- (i) $\delta \ge \min \{ \mu_A(x), \mu_B(xy) \}$
- (ii) $\delta \le 1 \max \{ \mu_A(x), \mu_B(xy) \}$
- (iii) $\delta \ge \sigma r \le d(\mu(x), \mu(y))$ Where $d(\mu(x), \mu(y)) = |\mu(x) \mu(y)|$ and $\mu(x), \mu(y)$ are the membership of vertices or edges

Definition 2.4.

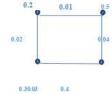
A path P is called a cycle if $V_1 = V_n$ for $n \ge 3$, then a cycle is called a fuzzy cycle. If it contains more than one weakest arc.

Definition 2.5.

A bijection ω is a function from the set of all nodes and edges of to [0, 1] which assign each nodes $A^{\omega}(V_i)$, $A^{\omega}(V_j)$ and edges $B^{\omega}(V_i, V_j)$ a membership value such that $B^{\omega}(V_i, V_j) \leq Min\{A^{\omega}(V_i), A^{\omega}(V_j)\}$ for all $V_i, V_j \in V$ is called fuzzy labeling.

Definition 2.6.

A graph is said to be **fuzzy labeling graph** if it has a fuzzy labeling and it is denoted by G^o.



Fuzzy Labelling





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Definition 2.7.

A fuzzy labeling graph G is said to be fuzzy **perfect intrinsic labeling** if $f: A \rightarrow [0,1]$ and $f: B \rightarrow [0,1]$ is bijective such that the membership values of edges are $\{z, 2 \ z \ 3 \ z, ..., \in Z\}$ and vertices are $\{(\epsilon+1)z, (\epsilon+2)z,(\epsilon+\nu)z\}$ where $\epsilon+\nu=N$ is the total number of vertices and edges and let z=0.1 for N>6.

Definition 2.8:

The Bi-magic constant in an Interval Valued Fuzzy Perfect Intrinsic Bi-Magic Graph(IVFPIBMG) is said to be mock constant ' $\gamma_m = [\gamma_m^- \gamma_m^+]$ ' if γ_m^- is equal to $\sigma_A^-(x) + \mu_B^-(xy) + \sigma_A^-(y)$ and γ_m^+ is equal to $\sigma_A^+(x) + \mu_B^+(xy) + \sigma_A^+(y)$ for some $x,y \in V$ with $\gamma_s \neq \gamma_w$.

Definition 2.9:

An interval valued fuzzy graph is said to be an Interval Valued Fuzzy pseudointrinsic Bi-magic graph if it contains a mock constant ' $\gamma_m = [\gamma_m^- \gamma_m^+]$ ' which is denoted by ' $G_{p^-}[G_p^- G_p^+]$ '

Theorem 2.10

Any fuzzy graph can be converted into an interval valued fuzzy labeling graph.

Interval Valued Fuzzy Non-Prime pseudo intrinsic Bi-magic graphs.

Definition 3.1:

Let G be an Interval Valued Fuzzy Pseudo Intrinsic Bi-magic Graph [IVFSIBM]. The prime strength of G is denoted by δ and is defined as $\delta = \{\gamma_c + \gamma_m\}$ if γ_m is prime.

Definition 3.2:

Let G be an IVFSIBM graph. If δ is prime, then the graph G is called Interval Valued Fuzzy Prime Pseudo Intrinsic Bi-Magic Graph and it is denoted by G_{α} .

Definition 3.3:

Let G be an IVFSIBM graph. If δ is not prime, then the graph G is called Interval Valued Fuzzy non-prime pseudo intrinsic edge-magic graph and it is denoted by G_{β} .

Definition 3.4:

Let G be an IVFSIBM graph. If the mock constant λ_m which is not prime, then the graph is called the interval valued fuzzy composite pseudo intrinsic bi-magic graph.

Definition 3.5:

An interval valued fuzzy intrinsic bi-magic graph with two mock constants is said to be interval valued fuzzy double prime pseudo intrinsic bi-magic graph.

Definition 3.6:

Let G be an interval valued fuzzy double prime pseudo intrinsic bi-magic graph. The prime strength of G is denoted by δ_d and is defined as $\delta_d = \{\gamma_c + \gamma_{m_i}\}$ where ' γ_{m_i} ' is a mock constant

Definition 3.7:

Let G be a IVFDPSIBM graph. If δ is prime, then the graph is said to be prime double pseudo intrinsic edge-magic.

Theorem 3.8:

An arrow graph is interval valued fuzzy non-prime pseudo intrinsic bi-magic graph.

Proof:

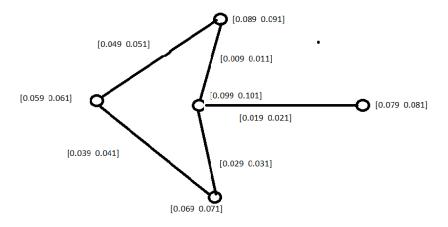
Let us prove the result by making use of the following example.





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Let G be an arrow graph. Consider the interval valued fuzzy intrinsic bi-magic labeling on the arrow graph.



$$\begin{split} &\sigma_A^-(v_1) + \mu_A^-(v_1v_2) + \sigma_A^-(v_2) = 0.089 + 0.049 + 0.059 = 0.197 = \gamma_c^- \\ &\sigma_A^+(v_1) + \mu_A^+(v_1v_2) + \sigma_A^+(v_2) = 0.091 + 0.051 + 0.061 = 0.203 = \gamma_c^+ \\ &\sigma_A^-(v_2) + \mu_A^-(v_2v_3) + \sigma_A^-(v_3) = 0.059 + 0.039 + 0.069 = 0.167 = \gamma_m^- \\ &\sigma_A^+(v_2) + \mu_A^+(v_2v_3) + \sigma_A^+(v_3) = 0.061 + 0.041 + 0.071 = 0.173 = \gamma_m^+ \\ &\sigma\mu_A^-(v_3) + \mu_A^-(v_3v_4) + \sigma_A^-(v_4) = 0.069 + 0.029 + 0.099 = 0.197 = \gamma_c^- \\ &\sigma_A^+(v_3) + \mu_A^+(v_3v_4) + \sigma_A^+(v_4) = 0.071 + 0.031 + 0.101 = 0.203 = \gamma_c^+ \\ &\sigma_A^-(v_4) + \mu_A^-(v_4v_5) + \sigma_A^-(v_5) = 0.099 + 0.019 + 0.079 = 0.197 = \gamma_c^- \\ &\sigma_A^+(v_4) + \mu_A^+(v_4v_5) + \sigma_A^+(v_5) = 0.101 + 0.021 + 0.081 = 0.203 = \gamma_c^+ \\ &\sigma_A^-(v_1) + \mu_A^-(v_1v_4) + \sigma_A^-(v_4) = 0.089 + 0.009 + 0.099 = 0.197 = \gamma_c^- \\ &\sigma_A^+(v_1) + \mu_A^+(v_1v_4) + \sigma_A^+(v_4) = 0.091 + 0.011 + 0.101 = 0.203 = \gamma_c^+ \\ &\text{Here}_{\gamma m}^-[\gamma_m^+\gamma_m^+]^-[0.167 \quad 0.173] \text{ which is prime, because both } \gamma_m^- = 0.167 and \gamma_m^+ = 0.173 \text{ are prime.} \\ &\text{By the definition of prime strength,} \\ &\delta = [\delta^-\delta^+] = \{[0.197 \quad 0.203] + [0.167 \quad 0.173]\} \\ &= [0.197 + 0.167 \quad 0.203 + 0.173] \\ &= [0.364 \quad 0.376] \end{split}$$

From the above, the strength of G is non-prime. So, we can conclude that an arrow graph under the interval valued fuzzy intrinsic labelling is an interval valued fuzzy non-prime pseudo intrinsic bi-magic graph.

Theorem 3.9:

A complete graph with four vertices K4 is an interval valued fuzzy non-prime pseudo intrinsic bi-magic.

Friendship Graph (Fn)

The friendship graph F can be constructed by joining n copies of the cycle graph C_3 with a common vertex. The graph F_2 is isomorphic to the butterfly graph.

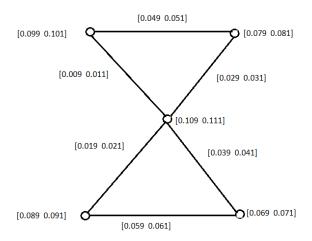
Theorem- 3.10

The butterfly graph F_2 is an interval valued fuzzy non-prime pseudo intrinsic edge-magic graph. Let G be a butterfly graph .i.e, A butterfly graph can be construct by joining 2-copies of the cycle graph with a common vertex.





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In the above graph, we applied the interval valued fuzzy intrinsic labelling for all the vertices & edges.

$$\begin{split} &\sigma_A^-(v_1) + \mu_A^-(v_1v_2) + \sigma_A^-(v_2) = 0.099 + 0.009 + 0.109 = 0.217 = \gamma_c^- \\ &\sigma_A^+(v_1) + \mu_A^+(v_1v_2) + \sigma_A^+(v_2) = 0.101 + 0.011 + 0.111 = 0.223 = \gamma_c^+ \\ &\sigma_A^-(v_2) + \mu_A^-(v_2v_3) + \sigma_A^-(v_3) = 0.109 + 0.019 + 0.089 = 0.217 = \gamma_c^- \\ &\sigma_A^+(v_2) + \mu_A^+(v_2v_3) + \sigma_A^+(v_3) = 0.111 + 0.021 + 0.091 = 0.223 = \gamma_c^+ \\ &\sigma_A^-(v_3) + \mu_A^-(v_3v_4) + \sigma_A^-(v_4) = 0.089 + 0.059 + 0.069 = 0.217 = \gamma_c^- \\ &\sigma_A^+(v_3) + \mu_A^+(v_3v_4) + \sigma_A^+(v_4) = 0.091 + 0.061 + 0.171 = 0.223 = \gamma_c^+ \\ &\sigma_A^-(v_4) + \mu_A^-(v_4v_5) + \sigma_A^-(v_5) = 0.069 + 0.039 + 0.109 = 0.217 = \gamma_c^- \\ &\sigma_A^+(v_4) + \mu_A^+(v_4v_5) + \sigma_A^+(v_5) = 0.071 + 0.041 + 0.111 = 0.223 = \gamma_c^+ \\ &\sigma_A^-(v_5) + \mu_A^-(v_1v_5) + \sigma_A^-(v_1) = 0.079 + 0.049 + 0.099 = 0.227 = \gamma_m^- \\ &\sigma_A^+(v_5) + \mu_A^+(v_1v_5) + \sigma_A^+(v_1) = 0.081 + 0.051 + 0.101 = 0.233 = \gamma_m^+ \\ \end{split}$$

Here $\gamma_m = [\gamma_m^- \gamma_m^+] = [0.227 \quad 0.233]$ which is prime, because both $\gamma_m^- = 0.227$ and $\gamma_m^+ = 0.233$ are prime.

By the definition of prime strength,

$$\begin{split} \delta_{\rm d} &= \left[\delta_d^- \, \delta_d^+ \right] = \left\{ \left[\gamma_c^- \gamma \right] + \left[\gamma_m^- \gamma_m^+ \right] \right\} \\ &= \left\{ \left[0.217 \quad 0.223 \right] + \left[0.227 \quad 0.233 \right] \right\} \\ &= \left[0.217 + 0.227 \quad 0.223 + 0.233 \right] \\ &= \left[0.444 \quad 0.456 \right] \end{split}$$

From the above, the prime strength of G is not prime. So, we conclude that the butterfly graph is aninterval valued fuzzy non-prime pseudo intrinsic bi-magic graph.

Theorem 3.11:

Every interval valued fuzzy pseudo intrinsic bi-magic is should not be a prime pseudo intrinsic bi-magic.

Proof

Let G be ainterval valued fuzzy pseudo intrinsic bi-magic. By our assumption, the mock constant $\gamma_m = [\gamma_m^- \gamma_m^+]$ should appear but it is not necessary prime. The following cases are arising:

Case (i): $\gamma_m = [\gamma_m^- \gamma_m^+]$ is prime and $\gamma_c = [\gamma_c^- \gamma_c^+]$ is not prime.

Here $\gamma_m = [\gamma_m^- \gamma_m^+]$ is prime, the prime strength is not a prime.

In this case, G should be non-prime pseudo intrinsic Bi-magic. Refer Theorem 3.8.

Case (ii): $\gamma_m = [\gamma_m^- \gamma_m^+]$ is prime and $\gamma_c = [\gamma_c^- \gamma_c^+]$ is prime.

Here $\gamma_m = [\gamma_m^- \gamma_m^+]$ is prime, the prime strength is not a prime.

In this case, G should be a non-prime pseudo intrinsic Bi-magic.

From the above observation, G should be a non-prime pseudo intrinsic Bi-magic in both the cases.





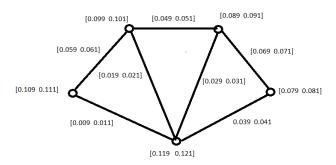
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Theorem 3.12

An interval valued fuzzy gem graph is a non-prime double pseudo intrinsic bi-magic.

Proof

Let G be an interval valued fuzzy gem graph. Apply interval valued fuzzy intrinsic bi-magic labelling,



```
\sigma_A^-(v_1) + \mu_A^-(v_1v_2) + \sigma_A^-(v_2) = 0.099 + 0.049 + 0.089 = 0.237 = \gamma_c^-
\sigma_A^+(v_1) + \mu_A^+(v_1v_2) + \sigma_A^+(v_2) = 0.101 + 0.051 + 0.091 = 0.243 = \gamma_c^+
\sigma_A^-(v_2) + \mu_A^-(v_2v_3) + \sigma_A^-(v_3) = 0.089 + 0.069 + 0.079 = 0.237 = \gamma_c^-
\sigma_A^+(v_2) + \mu_A^+(v_2v_3) + \sigma_A^+(v_3) = 0.091 + 0.071 + 0.081 = 0.243 = \gamma_c^+
\sigma_A^-(v_3) + \mu_A^-(v_3v_4) + \sigma_A^-(v_4) = 0.079 + 0.039 + 0.119 = 0.237 = \gamma_c^-
\sigma_A^+(v_3) + \mu_A^+(v_3v_4) + \sigma_A^+(v_4) = 0.081 + 0.041 + 0.121 = 0.243 = \gamma_c^+
\sigma_A^-(v_4) + \mu_A^-(v_4v_5) + \sigma_A^-(v_5) = 0.119 + 0.009 + 0.109 = 0.237 = \gamma_c^-
\sigma_A^+(v_4) + \mu_A^+(v_4v_5) + \sigma_A^+(v_5) = 0.121 + 0.011 + 0.111 = 0.243 = \gamma_c^+
\sigma_A^-(v_5) + \mu_A^-(v_1v_5) + \sigma_A^-(v_1) = 0.109 + 0.059 + 0.099 = 0.267 = \gamma_m^-
\sigma_A^+(v_5) + \mu_A^+(v_1v_5) + \sigma_A^+(v_1) = 0.111 + 0.061 + 0.101 = 0.273 = \gamma_m^+
\sigma_A^-(v_1) + \mu_A^-(v_1v_4) + \sigma_A^-(v_4) = 0.099 + 0.019 + 0.119 = 0.237 = \gamma_c^-
\sigma_A^+(v_1) + \mu_A^+(v_1v_4) + \sigma_A^+(v_4) = 0.101 + 0.021 + 0.121 = 0.243 = \gamma_c^+
\sigma_A^-(v_2) + \mu_A^-(v_2v_4) + \sigma_A^-(v_4) = 0.089 + 0.029 + 0.119 = 0.237 = \gamma_c^-
\sigma_A^+(v_2) + \mu_A^+(v_2v_4) + \sigma_A^+(v_4) = 0.091 + 0.031 + 0.211 = 0.243 = \gamma_c^+
Here\gamma_m = [\gamma_m^- \gamma_m^+] = [0.267 \quad 0.273] which is not prime, because both \gamma_m^- = 0.267 and \gamma_m^+ = 0.273 are not prime.
By the definition of prime strength,
\delta_{\mathbf{d}} = [\delta_d^- \delta_d^+] = \{ [\gamma_c^- \gamma_c^+] + [\gamma_m^- \gamma_m^+] \}
                   = \{ [0.237 \ 0.243] + [0.267 \ 0.273] \}
                   = [0.237 + 0.267 \quad 0.243 + 0.273]
                   = [0.504 \ 0.516]
```

So, here we get one mock constant which is not prime. Hence interval valued fuzzy pseudo intrinsicgem graph is a composite bi- magic graph.

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REVIEW ARTICLE

Virechana Therapy as an Alternative Approach for Reducing Oxidative Stress: A Comprehensive Review

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ABSTRACT

Virechana, a form of Shodhana Karma, involves the expulsion of Doshas through the "Adhobhaga" or lower pathways, specifically the anal route. This therapeutic medicated purgative therapy aims to eliminate vitiated Dosha and Malas (waste material) from the body. Widely recognized for its role in bio-purification and detoxification, Virechana is employed both in treating various diseased conditions and as a preventive measure for maintaining health in individuals. The primary target of this therapy is the expulsion of vitiated *Pitta dosha*, making it particularly effective in addressing diseases originating from this imbalance. Compared to other purification therapies like Vamana, Virechana is considered less complex and carries a lower probability of complications. Its simplicity and effectiveness contribute to its widespread use as a routine Shodhana therapy. The Sharadiya Virechan variant specifically focuses on purification therapy during the autumn season to control Pitta Dosha. This review explores the potential of Virechana therapy in reducing oxidative stress, a condition characterized by an imbalance between the production of reactive oxygen species (ROS) and the body's antioxidant defense. To interpret the impact of virechana (Bio-purification) on Oxidative stress. To take a review on virechana, To interpret the efficacy of virechana on oxidative stress

Keywords: Langhana, Virechana, importance of Langhana, oxidative stress, concept of oxidative stress management in Ayurveda





Manjusha Sonpipare and Pradnya Dandekar

INTRODUCTION

Ayurveda, often referred to as the "Science of Life," is a holistic system of medicine that encompasses both preventive and curative aspects of treatment [1]. In the contemporary era, unhealthy dietary habits, lifestyle changes, and mental stresses have emerged as significant contributors to oxidative stress. Ayurveda, recognizing the importance of preventive healthcare, provides guidance through practices such as Ritucharya (seasonal regimen), Dincharya (diurnal regimen), Pathyasevana, and Samshodhana Karma (detoxification). Emphasizing the significance of Samshodhana over samshamana, Ayurveda underscores the importance of preventing further vitiation of doshas to cure diseases from their roots, thereby preventing disease recurrence [2]. Panchakarma, a unique and widely practiced treatment in Ayurveda, includes detoxification therapies that play a crucial role in preventing various diseases. Among these therapies, Virechan Karma stands out as a commonly employed and less stressful procedure [3]. Ayurveda's guiding principle of "prevention is better than cure" is reflected in the concept of Rutucharya or 'Ritushodhan,' denoting purificatory measures undertaken by healthy individuals during seasonal transitions to maintain health and treat disorders. Ritucharya, a seasonal regimen, advocates Shodhana as the mainstream therapy to overcome any pathology arising from variations in Doshas during different seasons. The expulsion of aggravated Doshas during specific seasons is considered essential for counteracting their ill effects. The transitional period between seasons is particularly critical, leading to various health issues . Sharadiya Virechan, a purification therapy conducted during the autumn season, is specifically designed to control Pitta Dosha. Regardless of health status (Swastha or Atura), Ritushodhana is followed to prevent diseases and promote overall health [4].

Ayurveda suggests lifestyle interventions and natural remedies to restore balance between body elements. This involves an internal purification process, dietary modifications, and herbal remedies. The bio-purification achieved through *Shodhan* and *Shaman chikitsa* is believed to be effective in treating a range of diseases, including diabetes mellitus, rheumatoid arthritis, digestive problems, skin diseases, and stress. *Shodhana* therapy, a purification method, expels aggravated *doshas* from the body, eliminating internal causative factors and removing toxins and metabolic by-products. This process restores equilibrium to *doshas*, *dhatus*, and *malas* [5]. In *Adanakala*, poor digestion is exacerbated by *Vata* disorders during the rainy season. The weakening of *Agni* due to earth vapor, cloud humidity, and sour water further aggravates *Vatadi doshas*. In *Sharad Ritu*, the heat of the sunrays causes *Pitta* aggravation, affecting blood, and giving rise to related diseases. *Virechana* is recommended during *Sharad Ritu* as a purificatory measure to prevent and control *Pitta Prakopa* [6]. Ayurveda also employs *Langhana*, encompassing dieting, fasting, and weight-reducing therapies. It includes *Shodhana* and *Shamana* types, with *Shodhana chikitsa* aiming to eliminate toxins and vitiated *doshas* from the body [7]. The *Langhana* therapy is a procedure to prevent forthcoming diseases or treatment of existing diseases and also rejuvenation of the body [8]. *Virechana* therapy is a medicated purgation therapy, which cleans the *Pitta* and purifies blood by clearing the toxins from the body. This procedure is usually done in *Sharad Ritu* (i.e. from mid-September to mid-November) [9].

MATERIAL & METHOD

A systematic literature review will be conducted using databases such as PubMed, Scopus, and Google Scholar , DHARA, Research gate and various classical texts.

RESULT

The article discusses the principles and mechanisms underlying *Virechana*, emphasizing its role in promoting overall well-being. The connection between *Virechana* therapy and oxidative stress reduction is explored, considering its potential implications in preventing and managing diseases associated with increased oxidative stress.





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NEED FOR STUDY

Today people live a life that consists of busy routines, irregular food habits and other unhealthy lifestyle that leads to the buildup of toxins in the body. These toxins and seasonal changes vitiate *Tridoshas* in healthy individuals that cause many health related medical conditions. In *Ayurveda*, *Shodhana chikitsa* is advised to eliminate toxins, and also beneficial for improving digestion and circulation, eradicating disease, restoring *dosha* balance and boostering energy levels. Due to vitiated and irregular consumption of unhealthy food, *Agni* gets vitiated and responsible for undigested food causing formation of *Aam* (Toxic substance, undigested or partially digested substance).

REVIEW OF LITERATURE

Langhana

Treatment that produces lightness in the body is known as *langhana* [10]. Reducing therapy may be applied in various forms as four types of evacuation, thirst, exposure to wind and the sun, digestive measures, fasting and physical exercise [11]. Those having big body and strength, abundant *kapha*, *pitta*, blood and association of *vitiated vata* should be subjected to reducing therapy by means of evacuation [12]. *Ayurveda* the ancient science of life describes various types of treatments in context of healthy individual and also diseased one. Amongst them *shadvidhopkrama* bears a lot of significance in todays life. *Shadvidhopkrama* means union of six types of treatments principles, viz *Langhana-Bruhana*, *Rukshana-Snehana*, *Swedana-Stambhana* [13]. Out of these six therapies *Ayurveda* advocates two basic treatment principles which are termed as *Brumhana* and *Langhana upkramas*. Management of all the disease occurs mainly in or around these two principles. *Langhana upakarma* is the therapy by which one can feel lightness. Increased *kapha dosha* obstructed body channels. So when vitiated *kapha* is associated with *pitta dosha*, then mainly the *langhana* treatment is adopted [14].

Virechana (purgation)

Virechana is known as the process which is applied for the elimination of vitiated Doshas (morbid humors) through the Adhobhaga. Acharya Chakrapani while commenting on Adhobhaga explains it as the Guda (anal route). In certain circumstance the removal of Dosha through both their course i.e. 'Urdhva' and 'Adho' are together known by the term Virechana. As per assessment of Gangadhara, "Dosha nirharana from any route of the body is termed as Virechana given when pitta dosha is present in excess and accompanied related disorders. The Ayurvedic management of diseases in general, can be broadly grouped in to Shodhana and Shamana treatments [15]. The former is intended to eliminate excessively vitiated Doshas out of the body and there by eradicates disease as a whole, while the later is directed towards palliation of vitiated Doshas. However, in Ayurvedic Samhitas unequally give paramount importance to the Shodhana therapy, as it provides a complete cure. Acharya Charaka says that Doshas subdued by Langhana and Pachana therapies may provoke, but in case of Shodhana, there is seldom possibility of such recurrence. The toxins and metabolic toxic products responsible for the disease are eliminated from the body by Shodhana Chikitsa [16]. Shodhana Chikitsa is performed mainly by employing Panchakarma, it includes- Vamana, Virechana, Asthapana Basti, Anuvasana Basti and Nasyakarma [17]. In the Samhitas the Shodhana is specially indicated in Bahudoshavastha as a curative measure, in Rutucharya as preventive measure and prior to Rasayana Prayoga as a promotive measure [18]. Virechana is less stressful procedure than Vamana Karma. It has less possibility of complications and could be done easily. So it is widely used as Shodhana therapy in routine. It is more acceptable to all classes of patients. In an addition to the acceptability and popularity, the Virechana is considered as the best treatment for morbid and increased Pitta Dosha. This evacuative therapy eliminates aggravated *Dosha*, excreta, alleviates diseases, improves strength and complexion and if administered properly, endows the person with a long life. Virechana sharpens memory, ageing increases equity of organs, energy, and stability of all Dhatu, Agni [19].

The benefits of Virechana

It improves intelligence, gives strength to sense organs, stableness in dhatu, increases utsaha (feels powerful and energetic), increase hunger, also delayed ageing when the person takes virechana(accordingly to seasonal vairiations), it also destroyed PittajanyaVyadhi [20].





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Importance of Langhana

After Langhana Chikitsa persons will be associated with: feeling of hunger and thirst simultaneously; purity of heart and mind; clearness of belching and throat; decrease in severity of diseases; excitement increases; disappearance of lassitude. Langhana digests Aamadosha and increase digestive power and establishes doshas in samyavastha. Langhana leads to decrease in intensity of dosha, increases digestive power and brings lightness in the body. Thirst and hunger develop well accordingly. Whenever Aamadosha increases in the body it disturbs the samyavstha of doshas, blocks the body channels, and leads to heaviness. In such condition langhana is best treatment whereby it helps in removing blockages of channels and brings lightness in body. Langhana is such type of karma, which reactivates the Agni in the Ama and agnisama yoga in Ama condition. In nidanaparivarjana or treating diseases langhana as upavasa is the first step to excludes all type of nidana sevana or causes of the diseases. Langhana chikitsa stops the formation of sammurcchana (dosh-dushya sammurchhana) and directly improves Agni and removes Ama [21].

Oxidative stress

Oxidative stress is a phenomenon caused by an imbalance between production and accumulation of oxygen reactive species (ROS) in cells and tissues and the ability of a biological system to detoxify these reactive products. ROS are normally generated as by-products of oxygen metabolism; despite this, environmental stressors (i.e., UV, ionizing radiations, pollutants, and heavy metals) and some drugs contribute to greatly increase ROS production, therefore causing the imbalance that leads to cell and tissue damage (oxidative stress) [29/50]. Superoxide radicals (O2), hydrogen peroxide (H2O2), hydroxyl radicals (OH), and singlet oxygen (O2) are commonly defined reactive oxygen species (ROS); they are generated as metabolic by-products by biological systems [22]. When ROS production increases, they start showing harmful effects on important cellular structures like proteins, lipids, and nucleic acids [23]. Cells consists of an antioxidant defensive system based mainly on enzymatic components, such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), to protect themselves from ROS-induced cellular damage[24]. Free radicals are generated from both endogenous and exogenous sources.

Immune cell activation, inflammation, ischemia, infection, cancer, excessive exercise, mental stress, and aging are all responsible for endogenous free radical production. Exogenous free radical production can occur as a result from exposure to environmental pollutants, heavy metals (Hg, Pb, Fe, and As), certain drugs (cyclosporine, gentamycin, and bleomycin), chemical solvents, cooking (smoked meat, used oil, and fat), cigarette smoke, alcohol, and radiations. When these exogenous compounds penetrate the body, they are degraded or metabolized, and free radicals are generated as by-products. When maintained at low or moderate concentrations, free radicals play several beneficial roles for the humans. For example, they are needed to synthesize some cellular structures and to be used by the host defense system to fight pathogens. If in excess, free radicals and oxidants give rise to a phenomenon known as oxidative stress; this is a harmful process that can negatively affect several cellular structures, such as membranes, lipids, proteins, lipoproteins, and deoxyribonucleic acid (DNA) [25]. Oxidative stress emerges when an imbalance exists between free radical formation and the capability of cells to clear them. For instance, an excess of hydroxyl radical and peroxynitrite can cause lipid peroxidation, thus damaging cell membranes and lipoproteins. This in turn will lead to Malondialdehyde (MDA) and conjugated diene compound formation, which are known to be cytotoxic as well as mutagenic[26]. If not strictly controlled, oxidative stress can be responsible for the induction of several diseases, both chronic and degenerative, as well as speeding up body aging process and cause acute pathologies (i.e., trauma and stroke) [27]. However, triggering of antioxidant mechanisms either by internal or external sources counteracts oxidative stress.

CONCEPT OF OXIDATIVE STRESS IN AYURVEDA

According to *Ayurveda*, *Ama* is the undigested portion that is not limited to the gastrointestinal tract and if present chronically can spread throughout the body to cause various diseases. *Ama* is formed due to *Agni-mandhya*, which can be defined as the loss of appetite or the potency to metabolize at both gastrointestinal (*Jatharagnipak*) and cellular level (*Dhatupak*). This correlates the concept of *Ama*, *Agni-mandhya*, metabolic dysfunction, and oxidative stress together. The approach to treat oxidative stress in *Ayurveda* is at multiple levels [28]. *Ayurveda* speaks the main cause of diseases is rooted in the impairment of the body's main fire, called *Jatharagni*, the fire of digestion. *Ayurveda* views





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that if this digestive fire is functioning properly, the whole body will be nourished properly, increasing lifespan and health of the body will be maintained. Hypo function or impaired function of these *Agnis* at various levels is the main factor concerned in the formation of *Ama* i.e. improper metabolism produces *Ama*. Further accumulation of byproduct of metabolism as well as metabolic waste that are not properly eliminated or utilized in the body can be considered as *Ama* [29]. In the same way, free radicals are also found to be the root cause of many diseases. The majority of free radicals that damage biological systems are oxygen-free radicals, and these are more generally known as "Reactive oxygen Species" (ROS). These are the main byproducts formed in the cells, and can initiate autocatalytic reactions so that molecules to which they react are themselves converted into free radicals to propagate the chain of damage. Oxygen, which is an important element for life, can under certain situations cause severe harmful effects in the human body. Most of the potentially harmful effects of the oxygen are due to the formation and activity of number of chemical compounds, known as Reactive oxygen species (ROS), which have tendency to donate oxygen to other substances resulting in formation of oxygen radicals. Line of Treatment of *Ama* includes - *Langhan*, *Deepan*, *Paachan* and *Shodhan* according to the *Doshas*. [30].

REVIEW ON VIRECHANA AND OXIDATIVE STRESS

- An Experimental Study on Anti-inflammatory and Antioxidant Effects of *Virechana* on FA Treated Rats showed that *Virechana* helps in decreasing the free radical generation and to increase in the endogenous antioxidant system. *Virechana Karma* helps in elevation of pro antioxidant systems in the body. *Virechana Karma* Suppresses free radical generation mechanism [31].
- A case study on Alcoholic liver disease on ," MANAGEMENT OF ALCOHOLIC LIVER CIRRHOSIS THROUGH AYURVEDA -A CASE STUDY" showed that Ayurvedic tradition, a standardized treatment protocol was developed and implemented, consisting of *Nitya virechana* (regular purgatives), *shaman aushadhi* (palliative drugs) oral administration of single and compound herbal preparations combined with purificatory *shatkarma* measures as well as dietary and lifestyle regimens. The outcomes were assessed by measuring liver functions through specific clinical features and laboratory parameters. The total duration of the treatment including follow-up was 30 days. After the comprehensive Ayurvedic intervention, there was a complete remission of symptoms with normal hematological parameters. When, body is overloaded with toxins such as alcohol or is exposed to increased levels of heavy metals, at a certain point the protective detoxifying capacity of the liver runs out. The healthy liver cells dysfunction or die. Excessive and chronic alcohol consumption is the most common cause of liver cirrhosis. Ayurvedic management includes detoxification of body maintenances of proper metabolism and specific herbal drug show regeneration in fatty liver. Diet control and Yoga help in parasympathetic out flow in body which in turn regains healthy state of patient. Thus Ayurveda provides a holistic care to alcoholic liver disease by detoxification therapy [32].
- A case report on role of *nitya virechana* on *Ekakushtha* wsr to plaque psoriasis concluded that Ayurveda management by *Shodhan* and *Shaman* therapy in psoriasis or *Ekakushta* was *Nitya Virechana* and *Shamana Yoga*, which helped in the removal of vitiated *Dosha* from the body and opened the *Strotomukh* and brought *Samyavastha* of *Doshas*. *Virechana* is equally beneficial for the promotion and preservation of health by removing toxic wastes, by balancing *Tridoshas*, and by correcting *Agni* [33].

DISCUSSION

Panchkarmas, or biopurification methods, represent a key aspect of Ayurveda for treating bodily disorders. These five specially designed internal purification procedures aim to bring the biological system back to balance, promote rapid rejuvenation, and enhance the therapeutic effects of medicines. The process of eliminating waste products is known as *shodhana* (purification). *Virechana* is considered the most crucial therapy for *Pitta* in Ayurveda. It effectively removes the entire root cause of *Pitta Dosha*, leading to the pacification of *Pitta*-related manifestations in the body.





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Ayurveda recommends Virechana for the treatment of Pitta disorders, as it not only eliminates Pitta but also influences Kapha and Vata Doshas. Mild purgation is even suggested in Vata Chikitsa Upkrama in the Ashtang Hruday sutrasthan. While Virechana acts on all three Doshas, it holds particular significance as a purification treatment for Pitta. Ayurveda recommends undertaking Virechana during the Sharad Rutu due to the aggravated Pitta during this season. It is suitable for maintaining health in healthy individuals and treating various diseases where Virechana Karma is indicated. This evacuative therapy serves to eliminate aggravated Doshas and excreta, alleviate diseases, enhance strength and complexion, and, if administered correctly, promote a longer life. Virechana is known to sharpen memory, increase the acuity of organs, boost energy, stabilize all Dhatus (tissues), Agni (digestive fire), and delay the aging process. Patients, including foreigners, find Virechana more acceptable due to its inclusion of snehapana (oleation) and purgation, which can be carried out at home. In contrast, Vamana is generally avoided by patients due to fears of complications, making Virechana a safer alternative Virechana Karma involves expelling Doshas through the lower part, namely the rectum (Guda). The Doshas, even those from the stomach (Amashaya), are directed to the intestines (Pakwashaya) and eliminated through the anal passage (Gudamarga). This process eliminates waste, whether in a digested or undigested state, along with excess fluid components. It is a relatively gentle procedure and is considered an effective treatment for excessive and imbalanced Pitta Doshas. Virechana is also employed as a treatment for conditions involving Pitta-related imbalances, Kapha-related imbalances, and situations where Pitta has migrated to Kapha-dominant areas. It's important to note that Virechana, unlike modern purgatives, is not simply aimed at facilitating bowel movements but is a comprehensive therapeutic approach with both systemic and local effects. In traditional texts, it is clearly stated that these procedures, especially Virechana, serve as curative, preventive, and health-promoting measures. These effects may result from subtle cellular changes, modulating physiological, biochemical, and immunological activities at the molecular level.

CONCLUSION

In conclusion, Virechana stands out as a crucial therapeutic procedure in Ayurveda, specifically addressing imbalances related to Pitta Dosha. As one of the Panchkarmas, it plays a vital role in biopurification, aiming to bring the body back to balance, rejuvenate the system, and enhance the efficacy of medicinal treatments. Recommended during the Sharad Rutu, Virechana not only eliminates Pitta but also influences Kapha and Vata Doshas, making it a versatile and holistic approach. The benefits of Virechana extend beyond mere purgation, encompassing the alleviation of diseases, enhancement of strength and complexion, and promotion of a longer and healthier life. Its safety and acceptability, especially due to the inclusion of oleation and the ability for some aspects to be carried out at home, make it a preferred choice for patients. The procedure's systemic and local effects, along with its curative, preventive, and health-promoting attributes, underscore its significance in Ayurvedic medicine. This Ayurvedic practice, deeply rooted in traditional texts, goes beyond modern purgatives by considering both the physical and molecular aspects, thereby contributing to the modulation of physiological, biochemical, and immunological activities. In essence, Virechana emerges as a time-tested and effective methodology that not only addresses immediate health concerns but also serves as a preventative and health-promoting measure, aligning with the holistic principles of Ayurveda. Based on the results, the study implies that Virechana Karma could be beneficial in reducing oxidative stress by decreasing free radical generation and enhancing the body's natural antioxidant defense mechanisms.

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RESEARCH ARTICLE

Heart Guard: A Smart Approach to Detective Cardiovascular Conditions using Machine Learning

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ABSTRACT

One of the more complicated infections is heart disease, which affects a lot of people worldwide. Timely and accurate identification of cardiac disease plays a vital role in healthcare, particularly in the specialty of cardiology. We provided a precise and effective framework in this article for diagnosing cardiac illness, and it is based on AI techniques. The framework is developed based on calculations of order and includes assistive vector machine Although basic highlighted choice computations, such as Relief, Minimal repetition maximal pertinence, and least supreme shrinkage determination administrator, have been used, standard methods such as logistic regression, artificial neural organization, K-closest neighbour, Naïve bayous, and decision tree have also been used. Moreover, Additionally, learning the recognized processes for model appraisal and hyperparameter tuning have been accomplished through the use of the leave one subject out cross-approval technique. The classifiers exhibits are evaluated using presentation estimating measurements. The classifiers' exhibits are monitored based on selected highlights determined by highlights determination calculations. The test results demonstrate the feasibility of the proposed include determination calculation (FCMIM) in conjunction with classifier support vector machines for the planning of a significant level smart framework to identify heart disease. The proposed finding framework (FCMIM-SVM) achieved high precision in comparison to previously proposed techniques. Moreover, the proposed framework can easily be implemented in healthcare for the identification of heart disease.

Keywords: FCMIM, Vector Machine, Heart illness, FCMIM-SVM, Cardiology.





Lakshmipriyaa and Aathithyan

INTRODUCTION

Heart disease is a complicated illness that affects a large number of people worldwide. In healthcare, especially in the field of cardiology, early and effective detection of cardiac disease is crucial. This article describes a convolution neural network-based, accurate, and efficient approach for diagnosing heart problems. Quick conditional mutual information (FCMIM) FS computation for determination and subsequent highlights are fed into classifiers to increase prediction accuracy and reduce computation time. The classifiers' exhibits have been examined in relation to the selected highlights of the suggested FS calculation and the standard condition of the workmanship FS calculations. Identify weak points in the dataset that affect how the classifiers are displayed. Eventually, the heart disease (HD) can be successfully distinguished using the heart illness recognizable proof framework (FCMIM-SVM). In this investigation, the diagnosis of HD was made using a machine learning-based approach. To identify HD, machine learning predictive models such as ANN, LR, K-NN, SVM, DT, and NB are employed. The features have been chosen using the industry-standard state-of-the-art features selection algorithms, including Relief, mRMR, LASSO, and Local-learning-based features-selection (LLBFS). For feature selection, we also suggested the fast conditional mutual information (FCMIM) features selection approach. Optimal hyper-parameter selection for optimal model selection has been achieved by the application of the Leave-One-Subject-Out Cross-validation (LOSO) technique.

LITERATURE SURVEY

Identifying The Predictive Capability of Machine Learning Classifiers for Designing Heart Disease Detection System. Author: Amin ul Haq, Jianping Li. Year: 2019

It is undoubtedly unreliable to analyse cardiac diseases using receipt-based processes or standard clinical-based methodologies. However, for the diagnosis of cardiovascular ailment, non-receipt-based methods are more convincing. Thus, in this research, we evaluate the performance of various Machine Learning (ML) classifiers and deep learning classifiers for the purpose of identifying evidence of heart disease. To find out which AI classifier is more effective at analysing heart disease, six classifiers and BPNN were used. The important highlights were identified using the element choice calculation help, and classifier exhibitions were also logged based on these selected highlights. To further improve the classifier's performance, troope AI techniques (boosting, sacking, and stacking) were applied. Furthermore, k-folds cross-approval procedures were also applied. Furthermore, because deep learning computations do not require highlight determination calculations and automatically choose important highlights for excellent results, reverse engendering neural networks (BPNNs) were also used for characterisation. Based on evaluation metrics for model execution, the SVM (RBF) outperformed other classifiers with complete highlights with 86% accuracy and selected includes with 88% precision. SVM achieved a 92.30% grouping precision using ensemble learning techniques.

Decision Support System for Choosing Daycare in Surabaya City Using Analytical Hierarchy Process (AHP). Author: KholidFathoni, Ira Prasetyaningrum Year: 2019

Due to financial constraints, women are choosing to work, which means they are unable to be with their children all the time. As a result, they typically choose daycare when they can. They are unable to find any information regarding childcares, specifically profiles and areas, due to the schedules. Thus, parents require a data structure that can provide information about daycare and encourage the selection. The purpose of this study is to provide a framework that provides information on each childcare facility as well as suggestions for childcare so that parents can use it. Analytical Hierarchy Process (AHP), a multi-standard dynamic method, was used to lead the exploration's dynamic framework. The position of the client makes a proposition. The investigation concludes that the framework can provide information and recommendations about child care and can handle guardian concerns.





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Predicting Heart Disease at Early Stages Using Machine Learning: A Survey

Author: Rahul Katarya Year:2018

Medical care professionals have always had to perform the fundamental and challenging role of predicting and diagnosing cardiac illness. Clinics and other facilities are providing expensive procedures and activities to address heart infections. In light of this, it will be beneficial for people all over the world to anticipate cardiac sickness in its early stages so they can take necessary action before it worsens. A major problem in modern times is coronary illness, which is primarily caused by alcohol consumption, tobacco use, and a lack of physical activity. When making decisions and projections from the vast array of data provided by the health care sector, machine learning exhibits strong results over the long run. The artificial neural network (ANN), decision tree (DT), arbitrary woods (RF), support vector machine (SVM), innocent Bayes (NB), and k closest neighbor computation are a few of the controlled AI techniques used in this prediction of cardiovascular sickness. Additionally, these computations' exhibits are summarized.

Conceptualized Framework

In this investigation effort, we presented an AI based conclusion technique for the ID of HD. For the identifiable evidence of HD, machine learning predictive models such as ANN, LR, K-NN, SVM, DT, and NB are used. The highlights have been selected using the conventional best-in-class highlights determination computations, such as Relief, mRMR, LASSO, and Local-learning-based features-selection (LLBFS). For highlights determination, we also suggested using fast conditional mutual information (FCMIM) highlights choice calculation. The optimal hyperboundaries for the best model selection have been selected using the Leave-One Subject-Out Cross-Validation (LOSO) technique. Apart from this, a variety of presentation appraisal metrics have been applied to the evaluation of classifier exhibitions. The Cleveland HD data set has been used to test the suggested approach. Additionally, the suggested approach's demonstration has been examined using the best-in-class strategies currently in use in the literature, such as NB, the three-stage ANN (Artificial neural network) analysis framework, neural network ensembles (NNE), the ANN-Fuzzy-AHP diagnosis system (AFP), and the adaptive-weighted-fuzzy-system-ensemble (AWFSE). The accompanying obligations are part of the examination study. The excellent prediction accuracy of cardiac disease and the creation of more sophisticated hybrid algorithms are two benefits of the suggested approach.

RESULT

The R-Studio IDE is the foundation of the project. Version 3 of the GNU Affero General Public License is required to use the R-Studio IDE. The ability to share the code is ensured by the open-source AGPL v3 license. There are free and paid (commercial) versions of R-Studio Desktop and R-Studio Server. The IDE's format and edition determine what OS support it has. R-Studio Desktop is available in prepackaged packages for Linux, mac OS, and Windows. R-Studio Server and Server Pro are compatible with Cent OS, open SUSE, Red Hat Linux, Ubuntu, Debian, and SLES.

The R Environment

As is often the case with other data analysis software, the word "environment" is meant to describe it as a fully organized and integrated system as opposed to an incremental accumulation of extremely specific and inflexible instruments. Similar to S, R is built around a real computer language and lets users extend its capability by declaring new functions. Users can easily follow the algorithmic decisions made because a large portion of the system is written in the R dialect of S. C, C++, and Fortran code can be linked and invoked at run time for computationally demanding tasks. R objects can be directly manipulated by advanced users through C code. R is often considered a statistics system by its users. We like to conceptualize it as a setting in which statistical methods are applied. R can be (simplistically) expanded with packages. The R distribution comes with roughly eight packages, and a plethora of additional ones covering a vast array of contemporary statistics are accessible via the CRAN family of websites. R has its own documentation format, similar to LaTeX, that is used to provide thorough online documentation in several forms as well as hard copy documentation.





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Packages

Apart from the IDE, RStudio PBC and its staff members create, manage, and advertise several R packages. Among these are:

- Tidyverse -R data science packages, such as purrr, tidyr, and dplyr.
- Shiny An interactive online platform.
- RMarkdown –Users can easily combine text and code from different languages in Markdown documents; the most popular language to combine text and code from is C. Nevertheless, the platform allows users to combine R with Python, shell scripts, JavaScript, CSS, Julia, C, and other languages in a single RMarkdown document.
- Flex dashboard Release a dashboard with several connected data visualizations.
- **TensorFlow** library of open-source machine intelligence software. Using the high-level Keras and Estimator APIs and the core TensorFlow API, you can work efficiently with Tensor Flow through the R interface.
- Tidymodels Install and load the modelling and analysis-related packages from tidyverse.
- Sparklyr Binds the distributed machine learning library of Spark. You can quickly construct and fine-tune machine learning processes using Spark that are fully orchestrated within R by using the dplyr interface provided by sparklyr.
- String R Wrappers around the 'stringi' package that are simple, easy to use, and consistent
- **Reticulate** Offers an extensive toolkit for facilitating Python and R integration.
- **Plumber** Enables you to convert your existing R code into web API's by merely adding a couple of special comments.
- Knitr- Dynamic reports that combine HTML, Markdown, R, and TeX.
- Packrat Package dependency tool.
- Devtools Package development tool as well as helping to install R-packages from GitHub.
- SF allows for basic features, a standardized approach for decoding spatial vector data. Binds to 'GDAL' for both writing and reading statistics, to 'GEOS' for geometrical processes, and to 'PROJ' for projection transformations and datum manipulations.

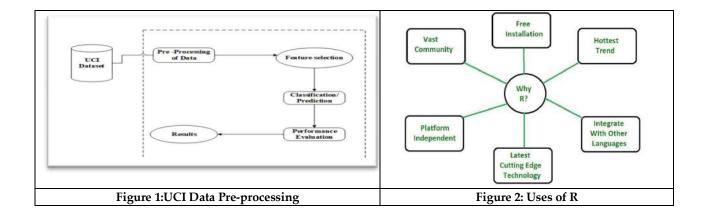
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RESEARCH ARTICLE

Impact of Tannery Effluents on Zooplankton in Urban Ecosystems through Heavy Metal Analysis and Physiochemical Profiling: A Case Study Along the Adyar River, Chennai, India

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ABSTRACT

This research investigates the dynamics of urban aquatic ecosystems along the Adyar River, with a specific focus on the impact of tannery effluents. The study aims to comprehend the intricate relationships within the aquatic ecosystem of Adyar River, Chennai, Tamil Nadu, India by conducting monthly sampling from June to November 2023 in four distinct areas: Dharkast Road, Anagaputhur Road, Cowl Bazar, and Manapakkam Bridge. Zooplankton abundance, heavy metal concentrations (specifically As, Cd, Cr, Pb), and physicochemical parameters were analysed to assess the ecological implications of tannery effluents. Sampling and preservation methods for zooplankton, heavy metal analysis, and physicochemical parameter measurements followed standard protocols. Cowl Bazaar emerged as the most affected site by tannery effluents, displaying significant disruptions in zooplankton populations and distinctive heavy metal patterns, particularly in chromium (Cr) and lead (Pb) concentrations. The findings emphasize the imperative for targeted interventions in specific areas, emphasizing the need for continuous monitoring to formulate effective conservation strategies and sustain the health and biodiversity of urban aquatic ecosystems. This research provides insights into the localized impact of tannery effluents on urban aquatic ecosystems, with Cowl Bazaar identified as the





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most profoundly affected area. The study highlights the urgency for focused interventions and ongoing monitoring to address environmental implications and ensure the sustained health of these ecosystems.

Keywords: Aquatic Ecosystems, Chennai- India, Heavy Metals, Physiochemical parameters, Tannery Effluents, Zooplankton.

INTRODUCTION

Within urban aquatic ecosystems, metals, encompassing microelements and heavy metals, naturally exist in relatively low concentrations, serving as essential components. However, the delicate balance of these elements has been disrupted, experiencing growth due to a combination of natural processes and human activities [1]. This augmentation poses a substantial threat to the ecological integrity of water bodies, emphasizing the significance of comprehending the dynamics surrounding metal presence. The persistence of heavy metals, characterized by their inability to degrade, designates them as enduring pollutants, accumulating in diverse environmental compartments, including water, soil, bottom sediments, and various organisms [2]. The advent of trace metal contaminants, originating from both industrial and domestic sources, introduces environmental hazards due to their persistent nature and inherent toxicity. Anthropogenic activities, notably industrial processes and inadequate wastewater treatment, have contributed to the increased prevalence of heavy metals, including cadmium, chromium, nickel, lead, manganese, and zinc, particularly in freshwater environments [3]. Tannery effluents, as significant contributors to heavy metal pollution, exert a pronounced influence on the aquatic ecosystem [4]. The nuanced interplay between essential metals, such as zinc and copper, which become toxic at elevated concentrations, and inherently hazardous metals like cadmium and lead, capable of posing risks even at low levels, underscores the intricacies of metal dynamics within aquatic environments [5]. Observable trends in the increased accumulation of non-degradable toxicants in animals inhabiting polluted waters underscore the urgency in estimating toxic metal levels within aquatic ecosystems. Regular monitoring practices encompassing water, sediment, and fauna become imperative, serving as essential tools to gauge the extent of metal contamination and assess its implications for public health standards and the overall well-being of aquatic life. The concern intensifies as these metals accumulate in vital components of aquatic ecosystems, such as water, plankton, and sediment, underlining the gravity of the situation.

Across the spectrum of aquatic organisms, plankton, being a key player in the aquatic food chain, serves as a primary food source in the entire ecological cycle, exerting an indirect influence on the human population dependent on water resources for sustenance. Heavy metals act as stressors for plankton growth, causing physical and morphological changes in aquatic ecosystems [6]. Environmental stressors, including heavy metals, induce the generation of reactive oxygen species (ROS) in microalgae, prompting defense mechanisms through antioxidant systems [7]. Both phytoplankton and zooplankton, integral components of plankton, exhibit a propensity for the bioconcentration of heavy metals. They actively participate in the biogeochemical cycling of elements, exhibiting a high bioaccumulation ability for heavy metals. However, their potential contribution to heavy metal transfer to higher trophic organisms underscores their role in ecological imbalances. However, mixed zooplankton organisms often exhibit higher metal concentrations due to untreated discharges from sewage treatment [8]. Thus, a comprehensive understanding of metal dynamics in plankton communities is vital for holistic ecosystem management and the preservation of aquatic biodiversity. This phenomenon is ubiquitous across various aquatic ecosystems, with the extent of bioconcentration contingent upon the species and prevailing seasonal conditions. Therefore, building upon the existing literature, this study aims to comprehensively assess the dynamics of heavy

metals, physicochemical parameters, and the influence of tannery effluents on zooplankton abundance in urban aquatic ecosystems along the Adyar River in Chennai, Tamil Nadu, India. Through a detailed case study conducted from June to November 2023, the research investigates the intricate relationships between heavy metal contamination, physicochemical characteristics, and the health of zooplankton communities in four designated urban aquatic complexes: Dharkast Road, Anagaputur Road, Cowl Bazaar, and Manapakkam Bridge. These areas are





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recognized as protected zones within the regions of the Adyar River, Chennai, Tamil Nadu, India. The primary focus is on understanding the specific impact of tannery effluents on the studied ecosystem, aiming to provide valuable insights for environmental conservation and sustainable management practices in urban aquatic environments.

MATERIALS AND METHODS

Sampling Sites

The water and plankton samples were collected monthly once from June 2023 to November 2023, encompassing both pre-monsoon and post-monsoon periods from selected aquatic complexes of Dharkast Road, Anagaputur Road, Cowl Bazaar and Manapakkam Bridge, situated within the regions of Adyar River, Chennai, Tamil Nadu, India (Figure 1).

Collection and Preservation of Zooplankton

The collection process involved the use of a conical-shaped monofilament nylon net, commonly referred to as a Plankton net, featuring a 0.5-micron mesh size and a 30 cm diameter at the mouth. Sampling was conducted at various locations in the pond's pelagic water, with water passing through the net, causing zooplankton to accumulate at the lower end. The condensed zooplankton was then carefully gathered into glass test tubes following Welch's protocol. Post-collection, the zooplankton materials were transferred into glass bottles and preserved using a 30% formalin solution, with approximately 250 ml samples treated for preservation. These preserved samples were subsequently transported to the Unit of Aquaculture and Aquatic Toxicology at The New College, Royapettah, Chennai - 600 014. For zooplankton identification, a Sedgwick-Rafter cell counter was employed under a light microscope. Expertise in species identification was supported by a set of pencil and ink drawings depicting observed species on postcards. The identification process followed the methods outlined by Moniruzzaman [9]. The quantitative enumeration of zooplankton involved using a Sedgwick-Rafter (S-R) cell counter measuring 50 mm in length, 20 mm in width, and 1 mm in depth. Prior to filling the S-R cell with the sample, cover glasses were diagonally positioned, and samples were carefully transferred using a large bore pipette to prevent air bubble formation. The S-R cell settled for a minimum of 15 minutes before enumeration using a compound microscope. Random sampling involved examining three fields for each sample, with counts averaged for accuracy. The number of zooplankton in the S-R cell was determined using a formula

$$No./ml = \frac{C \times 1000mm^3}{L \times D \times W \times S}$$

Where, *C* is the number of organisms counted, *L* is the length of each strip (S-R cell length) in mm, *D* is the depth of a strip (Whipple grid image width) in mm, *W* is the width of each stripe in mm, *S* is the number of strips counted. These counts were then adjusted to organisms per litre following the APHA guidelines from 1998 [10].

Heavy Metal Analysis

Samples were transferred to the laboratory for heavy metal analysis. The samples were transported to Analytical laboratory in ice boxes and preserved in a mechanical freezer maintained at -20°C. The samples were rinsed with deionized water prior to laboratory preparation and analyses. The collected samples were prepared for laboratory analysis of their heavy metal's levels. The samples were cleaned and transferred whole into an electric oven at 40°C. They were dried in the oven at this temperature for 24 hours and then pulverized in a clean dry porcelain mortar [11]. The pulverized samples were dried further for 1 hour at a reduced temperature of 20°C and put into clean dried bottles. Then, 3.0 g each of the pulverized and dried samples was weighed into a silica crucible and ashed in a muffle furnace at a temperature of 600°C for 5 hours [12] . The ashes were cooled to room temperature and sieved to remove bigger particles and then transferred into a 250 ml conical flask. Thereafter, 20 ml of concentrated HNO3 was added and diluted to 50 ml with deionised water and swirled gently after which the volume was made up to 100 ml with deionised water and analysed for heavy metals as with the water.





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Measurement of physicochemical parameters

Regular surface water samples were collected during the study period at regular interval. The surface water samples were collected in a precleaned polypropylene container for physical and chemical analysis. Samples were fixed with manganese sulphate and alkaline iodide in 250 ml BOD bottles to analyse the dissolved oxygen in field. Water quality parameters analysis was performed at Wasser Chemicals & Systems Private Ltd, Chennai. These parameters encompassed appearance, pH, color, odor, turbidity, total dissolved solids (mg/l), total hardness as CaCO₃ (mg/l), calcium (mg/l), magnesium (mg/l), chlorides (mg/l), sulphates (mg/l), sodium (mg/l), potassium (mg/l), dissolved oxygen (DO) (mg/l), BOD and COD (mg/l) and also pH value at 25°C. Further, water parameters were analysed as per methods described in APHA (1998) [10].

Statistical Analysis

The population density of each zooplankton group was calculated as the average number of individuals per litre. Heavy metal analysis in zooplanktons and water quality parameters were measured three times, and the data are represented as percentages using Microsoft Excel.

RESULTS AND DISCUSSION

Zooplankton Abundance from June to November 2023

The examination of zooplankton populations in the Adyar River's regions from June to November 2023, encompassing both pre-monsoon and post-monsoon periods, disclosed significant insights. A total of 706 rotifers, 227 calanoids, and 206 copepods, with a grand total of 1139 zooplankton individuals was identified, which highlights a dynamic picture of this particular ecosystem. These findings suggest potential implications for the water ecosystem, particularly in the context of the nearby tannery activities. The proximity to tannery effluents prompts consideration of their impact on zooplankton abundance. Tannery effluents, known for introducing pollutants into water bodies, may contribute to disruptions in the delicate balance of the ecosystem [13]. Understanding the specific effects of these effluents on zooplankton populations is essential to gauge the overall health of the Adyar River ecosystem. Furthermore, the observed variations in zooplankton, including rotifers, calanoids, and copepods, have consequences for the complicated dynamics of the aquatic food chain. As key components in the food web, changes in zooplankton abundance can potentially cascade through higher trophic levels, influencing the composition and abundance of various species [14]. To comprehend these dynamics and potential ecological consequences, further research into the drivers behind these fluctuations is imperative. In light of these findings, comprehensive investigations into the relationships between zooplankton populations and environmental variables, including the impact of tannery effluents, are recommended. This deeper understanding is crucial for formulating informed conservation and management strategies, ensuring the sustained health and ecological integrity of the Adyar River ecosystem.

Heavy Metal Levels in Zooplankton across different aquatic complexes

The comprehensive heavy metal analysis conducted on plankton samples obtained from Dharkast Road, Anagaputhur Road, Cowl Bazaar, and Manapakkam Bridge reveals distinct patterns of contamination, shedding light on the environmental impact of tannery effluents within the Adyar River ecosystems. The focus on arsenic (As), cadmium (Cd), chromium (Cr), and lead (Pb) provides valuable insights into the extent of pollution in these regions. Plankton, as integral components of aquatic food webs, serves as reliable indicators of environmental contamination due to their ability to accumulate heavy metals [15]. These findings also shed light on the extent of heavy metal pollution and its potential implications for aquatic organisms and ecosystem health. In Dharkast Road, the recorded average chromium concentration of the period from June to November stands at 3.4 mg/kg, while lead levels measure 4 mg/kg (Table 1). Similarly, at Anagaputhur Road, the average chromium levels for the said period increased notably to 106.2 mg/kg, while lead remained consistent at 4 mg/kg (Table 2). However, the most alarming findings emerge from Cowl Bazaar, where zooplankton samples exhibited exceptionally high average chromium levels at 213.5 mg/kg, accompanied by a slightly elevated lead concentration of 4.2 mg/kg (Table 3). Lastly, at Manapakkam Bridge, the average chromium contamination remained significant at 168.6 mg/kg, with lead levels





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were slightly lower at 3.1 mg/kg (Table 4). These results underscored the pervasive nature of heavy metal pollution, particularly in areas adjacent to tanneries. The average elevated concentrations of chromium and lead in zooplankton samples suggests that bioaccumulation from tannery effluent discharge, highlights the critical role of anthropogenic activities in contaminating aquatic environments. Among the sampled areas, Cowl Bazaar emerges as the most severely affected by tannery effluents, as indicated by the exceptionally high chromium levels detected in zooplankton. This finding emphasizes the urgent need for intervention to mitigate further contamination and protect the ecological integrity of the Adyar River ecosystem. Overall, the findings highlight the urgent need for targeted intervention measures in Cowl Bazaar due to the significant contamination observed in the area, particularly from tannery effluents. The exceptionally high levels of chromium detected in zooplankton samples underscore the severity of pollution and its potential consequences for ecosystem health and human well-being. To address these challenges, stringent regulatory frameworks and effective waste management practices within the tanning industry are imperative. By addressing the root causes of contamination and curtailing heavy metal discharge into aquatic environments, we can safeguard ecosystem health and ensure the sustainability of the Adyar River ecosystem. Additionally, ongoing monitoring and research efforts are essential to fully understand the extent of environmental contamination and to implement targeted measures to protect aquatic ecosystems and public health effectively, especially in areas like Cowl Bazaar that are most severely impacted by tannery effluents.

Comparative Analysis of Physicochemical Parameters Across Four Urban Aquatic Complexes (June-November 2023)

The comprehensive analysis of water quality across four distinct aquatic complexes—Dharkast Road, Anagaputhur Road, Cowl Bazaar, and Manapakkam Bridge-during the period from June to November 2023 (average) reveals distinctive characteristics while demonstrating overall stability in various physicochemical parameters. Starting with Dharkast Road, several alarming findings emerged, indicating a significant level of pollution. The water was visibly cloudy with a pH reading of 6.82, indicating slightly acidic conditions. The significant turbidity level of 14.50 NTU implies the presence of considerable suspended particles in the water, likely originating from industrial discharges. Moreover, the elevated levels of chloride (200.33 mg/l) and sulfate (9.33 mg/l) point towards contamination from industrial activities, with tanneries being a potential source. The presence of pollutants such as iron (4.75 mg/l) and lead (3.06 mg/l), which is exceeding permissible limits, could have attributed to tannery effluents and further underscore the severity of pollution in this area, necessitating urgent remedial actions (Table 5). Moving to Anagaputur Road, there are relatively lower pollution indicators compared to Dharkast Road, indicating a slightly better water quality. The water exhibited similar turbid clear appearance but with a higher pH of 7.25. While the color and turbidity were lower compared to Dharkast Road, other parameters such as electrical conductivity, total dissolved solids, and total hardness were found to be slightly elevated. Chloride and sulfate levels were also prominent, indicating potential industrial influence. However, the presence of contaminants such as iron (0.81 mg/l) and lead (3.76 mg/l) still raises concerns, albeit at lower levels, suggesting the presence of tannery effluents (Table 6).

These findings suggest that while pollution levels may be somewhat reduced in this area, industrial activities, including tanneries, continue to impact water quality. The Cowl Bazaar water sample presented a concerning picture, with significant pollution indicators suggesting significant contamination. The relatively high turbidity (2.49 NTU) and elevated levels of chloride (209.67 mg/l) indicated substantial pollution, likely originating from tannery effluents and other industrial sources. Further, the water appeared turbid clear, with pH and other parameters resembling those of Anagaputur Road. However, chloride and sulfate levels were also higher, along with total iron, silica, and sodium, indicating potential industrial contamination. In addition, the presence of pollutants like iron (1.17 mg/l) and lead (0.20 mg/l) further highlights the extent of contamination in this area, but still warrants attention concerning tannery effluents, necessitating immediate attention and remediation efforts (Table 7). Finally, at Manapakkam Bridge, water sample also exhibited pollution indicators, albeit to a slightly lesser extent compared to Cowl Bazaar. The water exhibited turbid clear appearance, while the pH levels fluctuated slightly from 7.22 to 7.28, and turbidity showed minor variations (3.5 to 3.8 NTU). While total dissolved solids and total hardness were lower compared to other locations, chloride and sulfate levels were relatively high. Total iron was significantly elevated, indicating potential industrial pollution. Lead was detected at the higher level (0.87 mg/l) when compared with that of Cowl





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Bazaar, emphasizing significant contamination likely from tannery effluents (Table 8). Based on the parameters analysed, it appears that Cowl Bazaar is the area most affected by tannery effluents among the sampled locations along the Adyar River. Several indicators suggest significant industrial influence, particularly from tanneries, in this area. The elevated levels of chloride and sulfate, along with total iron, silica, and sodium, point towards substantial industrial contamination. Although the lead concentration was relatively lower compared to some other locations, it still indicates the presence of tannery effluents. Additionally, the overall physicochemical profile of water samples from Cowl Bazaar closely resembles that of areas with known industrial activity, reinforcing the likelihood of tannery effluent contamination. While other locations also show signs of pollution, Cowl Bazaar stands out as the most affected area based on the analysed parameters. Therefore, efforts to mitigate industrial pollution, particularly from tannery effluents, should be prioritized in Cowl Bazaar to protect the health of the Adyar River ecosystem and the well-being of surrounding communities. Implementing stringent regulatory measures and effective waste management practices in this area is crucial to minimize the adverse impacts of industrial pollution and ensure the long-term sustainability of the river ecosystem. In addition, the recorded Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) values varied among the four urban aquatic sites, indicating potential differences in water quality. Specifically, Dharkast Road exhibited DO levels of 4.05 mg/L, BOD of 2.7 mg/L, and COD of 22 mg/L; Anagaputur Road showed DO at 4 mg/L, BOD at 2.7 mg/L, and COD at 22.4 mg/L; Cowl Bazaar displayed DO at 3.4 mg/L, BOD at 2.6 mg/L, and COD at 22.6 mg/L; Manapakkam Bridge recorded DO at 4.25 mg/L, BOD at 3.1 mg/L, and COD at 23.1 mg/L; (Figure 2). These variations indicate differences in pollution levels across the sites, with higher BOD and COD values typically indicating greater organic pollution, often originating from sewage and industrial effluents. While all sites show signs of pollution, the results suggest that Manapakkam Bridge may be most affected by anthropogenic factors. Despite previous findings indicating that Cowl Bazaar is mostly impacted by tannery effluents based on physicochemical properties of water samples, the current results project Manapakkam Bridge as being more severely affected. This discrepancy may be attributed to various factors, including changes in pollution sources over time or specific characteristics of the sampling period. It underscores the dynamic nature of environmental pollution and the importance of ongoing monitoring and mitigation efforts to address pollution hotspots effectively and protect water quality in urban areas.

Interplay of Zooplankton Abundance, Heavy Metal Dynamics and Physicochemical Stability in Urban Aquatic Complexes

The intricate interplay of zooplankton abundance, heavy metal dynamics, physicochemical stability, and water quality parameters in aquatic complexes along the Adyar River offers a comprehensive perspective on environmental health. The examination of zooplankton populations in the Adyar River's regions from June to November 2023 provided valuable insights into the ecological dynamics of this aquatic ecosystem, especially in light of nearby tannery activities. The findings revealed a diverse zooplankton community, comprising 706 rotifers, 227 calanoids, and 206 copepods, totalling 1139 individuals. These numbers underscore the richness and complexity of the Adyar River ecosystem and its susceptibility to external influences, particularly from tannery effluents. The proximity to tannery effluents raises concerns about their influence on zooplankton abundance, necessitating an understanding of their specific effects on the delicate balance of the ecosystem. Tannery effluents, known to introduce pollutants into water bodies, may disrupt the delicate balance of the ecosystem. Understanding the specific effects of these effluents on zooplankton populations is crucial for assessing the overall health of the Adyar River ecosystem. The observed variations in zooplankton abundance in this study, including rotifers, calanoids, and copepods, can have cascading effects on the aquatic food chain, influencing the composition and abundance on higher trophic levels. Further research into the drivers behind these fluctuations is imperative for a comprehensive understanding of ecological consequences. Additionally, the comprehensive examination of heavy metal concentrations conducted on zooplankton across diverse aquatic complexes revealed distinct patterns of contamination, shedding light on the environmental impact of tannery effluents. Of notable concern is Cowl Bazaar and Manapakkam Bridge, where high chromium levels were detected, accompanied by slightly elevated lead concentrations, indicating significant influence from tannery effluents. Even in areas with lower heavy metal concentrations, such as Dharkast Road and Anagaputhur Road, pollutants were present, suggesting potential contamination from tannery effluents. Further, the physicochemical parameter analysis across the urban aquatic complexes highlighted distinctive characteristics and





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overall stability in water quality parameters. While Cowl Bazaar showed the highest industrial contamination based on various pollutants, Manapakkam Bridge exhibited more severe effects concerning parameters like Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD), indicating a more significant impact from anthropogenic factors, likely originating from sewage and industrial effluents. These findings paint a concerning picture of deteriorating water quality in this area, indicating a more significant impact from anthropogenic factors. Thus, continuous monitoring is crucial to evaluate the environmental implications of heavy metal contamination, especially concerning tannery activities. This study also highlights the importance of ongoing research for effective conservation strategies and ensuring the sustained health of diverse aquatic ecosystems.

CONCLUSION

In summary, the interplay of zooplankton abundance, heavy metal dynamics, and physicochemical stability in urban aquatic complexes highlights the intricate relationships between biological, chemical, and environmental factors. The significance of the mostly affected area, Cowl Bazaar, due to tannery effluents underscores the urgent need for targeted remediation efforts and stringent regulatory measures to safeguard ecosystem health and ensure the long-term sustainability of the Adyar River ecosystem.

ACKNOWLEDGMENTS

The authors would like to acknowledge Wasser Chemicals & Systems Pvt Ltd, Chennai, for their crucial role in conducting the physicochemical analysis of the water samples.

CONFLICT OF INTEREST

Nil

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Table 1. Heavy Metal Analysis in Plankton Samples from Dharkast Road, Adyar River, Chennai, Tamil Nadu, India

S.No	Heavy Metals	Unit	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Average
1.	Arsenic	mg/kg	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ
		0, 0	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)
2.	Cadmium	malka	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ
۷.	Caullium	mg/kg	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)	(LOQ:1.0)
3.	Chromium	mg/kg	3.45	3.43	3.45	3.23	3.4	3.3	3.4
4.	Lead	mg/kg	4.04	4	4.08	4.1	4.05	4	40

BLQ- Below Limit of Quantification; LOQ- Limit of Quantification

Table 2. Heavy Metal Analysis in Plankton Samples from Anagaputhur Road, Adyar River, Chennai, Tamil Nadu, India

								1	
S.No	Heavy Metals	Unit	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Average
1.	Arsenic	mg/kg	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)
2.	Cadmium	mg/kg	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)
3.	Chromium	mg/kg	106.54	106.5	106.4	106.5	105.6	105.6	106.2
4.	Lead	mg/kg	4.01	4	3.99	3.99	4.03	4.01	4.0

BLQ- Below Limit of Quantification; LOQ- Limit of Quantification

Table 3. Heavy Metal Analysis in Plankton Samples from Cowl bazaar, Adyar River, Chennai, Tamil Nadu, India

S.No	Heavy Metals	Unit	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Average
1.	Arsenic	mg/kg	BLQ (LOQ:1.0)	BLQ (LOO:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)
2.	Cadmium	mg/kg	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)
3.	Chromium	mg/kg	212.29	213.29	215.39	214.36	213.16	212.29	213.5
4.	Lead	mg/kg	4.17	4.18	4.14	4.12	4.18	4.17	4.2

BLQ- Below Limit of Quantification; LOQ- Limit of Quantification





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Table 4. Heavy Metal Analysis in Plankton Samples from Manapakkam Bridge, Adyar River, Chennai, Tamil Nadu, India

S.No	Heavy Metals	Unit	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Average
1.	Arsenic	mg/kg	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)
2.	Cadmium	mg/kg	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)	BLQ (LOQ:1.0)
3.	Chromium	mg/kg	168.6	168.5	168.82	168.58	168.59	168.6	168.6
4.	Lead	mg/kg	3.14	3.12	3.13	3.15	3.13	3.14	3.1

BLQ- Below Limit of Quantification; LOQ- Limit of Quantification

Table 5: Physicochemical Analysis of water from Dharkast road, Adyar River, Chennai, Tamil Nadu, India

S.No	Physicochemical Physicochemical	Unit	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23
	Analysis		,			•		
1	Appearance:		Turbid	Turbid	Turbid	Turbid	Turbid	Turbid
1	Арреагансе.	-	clear	clear	clear	clear	clear	clear
2	pH value at 25°C	-	6.84	6.8	6.81	6.81	6.82	6.83
3	Color	Hazen Unit	45	43	44	45	47	46
4	Odour	=	DA	DA	DA	DA	DA	DA
5	Turbidity	NTU	14	13	15	16	16	13
6	Electrical conductivity	Micromhos/cm	1020	1018	1019	1021	1022	1020
7	Total Dissolved Solids	mg/l	612	615	613	614	610	611
8	Total Hardness as CaCO ₃	mg/l	180	183	181	182	179	178
9	Calcium as Ca	mg/l	39	37	38	41	40	39
10	Magnesium as Mg	mg/l	20	17	21	18	22	19
11	Total Alkalinity as CaCO ₃	mg/l	314	311	315	312	313	310
12	Chlorides as Cl	mg/l	202	198	201	202	199	200
13	Sulfates as SO ₄	mg/l	10	8	8	9	11	10
14	Total Iron as Fe	mg/l	4.7	4.5	4.5	4.7	4.6	5.5
15	Silica (Reactive) as SiO ₂	mg/l	28	27	30	27	29	28
16	Sodium as Na	mg/l	57	57	56	55	58	55
17	Potassium as K	mg/l	6	5	6	6	5	5
18	Carbonate Hardness as CaCO ₃	mg/l	180	181	181	179	182	180
19	Chromium as Cr	mg/l	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)





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20	Cadmium as Cd	mg/l	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)
21	Lead as Pb	mg/l	3.06	3.05	3.05	3.06	3.04	3.07
22	Total Arsenic as As	mg/l	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)

Table 6: Physicochemical Analysis of water from Anagaputhur Road, Adyar River, Chennai, Tamil Nadu, India

Table	6: Physicochemical A	marysis or water in	tom Amagap	dullul Koau	, Auyai Kiv	er, Chemiai,	, ranin Nau	u, Illula
S.No	Physicochemical Analysis	Unit	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23
1	Appearance:	-	Turbid clear	Turbid clear	Turbid clear	Turbid clear	Turbid clear	Turbid clear
2	pH value at 25°C	-	7.25	7.23	7.24	7.25	7.26	7.25
3	Color	Hazen Unit	25	24	25	24	25	24
4	Odour	-	DA	DA	DA	DA	DA	DA
5	Turbidity	NTU	1.9	1.8	1.9	1.7	2	1.9
6	Electrical conductivity	Micromhos/cm	1140	1140	1139	1141	1140	1138
7	Total Dissolved Solids	mg/l	650	648	649	652	651	650
8	Total Hardness as CaCO ₃	mg/l	255	257	256	248	249	255
9	Calcium as Ca	mg/l	66	65	65	66	67	65
10	Magnesium as Mg	mg/l	22	22	23	22	21	21
11	Total Alkalinity as CaCO ₃	mg/l	312	312	312	313	311	312
12	Chlorides as Cl	mg/l	199	197	197	198	199	200
13	Sulfates as SO ₄	mg/l	29	29	28	27	29	28
14	Total Iron as Fe	mg/l	0.81	0.8	0.81	0.79	0.8	0.82
15	Silica (Reactive) as SiO ₂	mg/l	35	35	33	35	34	35
16	Sodium as Na	mg/l	56	55	56	55	57	54
17	Potassium as K	mg/l	6	4	6	5	6	5
18	Carbonate Hardness as CaCO3	mg/l	255	255	254	256	255	254
19	Chromium as Cr	mg/l	BDL (DL=0.1)					
20	Cadmium as Cd	mg/l	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)
21	Lead as Pb	mg/l	3.77	3.75	3.77	3.76	3.76	3.76
22	Total Arsenic as As	mg/l	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)





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Table 7: Physicochemical Analysis of water from Cowl Bazar, Adyar River, Chennai, Tamil Nadu, India

S.No	Physicochemical Analysis	Unit	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23
1	Appearance:	_	Turbid	Turbid	Turbid	Turbid	Turbid	Turbid
1	Арреагансе.	_	clear	clear	clear	clear	clear	clear
2	pH value at 25°C	-	7.03	7.06	7.03	7.05	7.06	7.1
3	Color	Hazen Unit	30	28	32	30	28	29
4	Odour	-	DA	DA	DA	DA	DA	DA
5	Turbidity	NTU	2.5	2.49	2.5	2.48	2.46	2.48
6	Electrical conductivity	Micromhos/cm	1098	1098	1096	1094	1095	1096
7	Total Dissolved Solids	mg/l	682	682	683	684	682	683
8	Total Hardness as CaCO ₃	mg/l	270	271	270	272	271	272
9	Calcium as Ca	mg/l	65	64	65	66	63	65
10	Magnesium as Mg	mg/l	25	24	23	22	24	23
11	Total Alkalinity as CaCO ₃	mg/l	286	285	288	285	286	287
12	Chlorides as Cl	mg/l	210	209	210	210	209	210
13	Sulfates as SO ₄	mg/l	57	55	56	54	57	55
14	Total Iron as Fe	mg/l	1.2	1.15	1.2	1.14	1.16	1.19
15	Silica (Reactive) as SiO ₂	mg/l	42	42	41	43	44	41
16	Sodium as Na	mg/l	62	62	61	65	63	62
17	Potassium as K	mg/l	8	7.5	7.3	7.6	7.8	7.9
18	Carbonate Hardness as CaCO3	mg/l	270	269	268	270	272	270
19	Chromium as Cr	mg/l	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)
20	Cadmium as Cd	mg/l	BDL (DL=0.1)					
21	Lead as Pb	mg/l	0.21	0.21	0.2	0.21	0.19	0.2
22	Total Arsenic as As	mg/l	BDL (DL=0.1)					





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Table 8: Physicochemical Analysis of water from Manapakkam Bridge, Adyar River, Chennai, Tamil Nadu, India

	8: Physicochemical A		ioni ivianapi	initum Dire		iver, enem		au, man
S.No	Physicochemical Analysis	Unit	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23
1	Appearance:	-	Turbid clear	Turbid clear	Turbid clear	Turbid clear	Turbid clear	Turbid clear
2	pH value at 25°C	-	7.26	7.24	7.22	7.28	7.27	7.25
3	Color	Hazen Unit	20	20	20	20	20	20
4	Odour	-	DA	DA	DA	DA	DA	DA
5	Turbidity	NTU	3.8	3.7	3.6	3.5	3.6	3.7
6	Electrical conductivity	Micromhos/cm	1160	1155	1150	1153	1157	1158
7	Total Dissolved Solids	mg/l	720	729	728	727	731	732
8	Total Hardness as CaCO ₃	mg/l	274	275	276	277	274	273
9	Calcium as Ca	mg/l	66	65	64	63	66	65
10	Magnesium as Mg	mg/l	26	25	24	27	27	26
11	Total Alkalinity as CaCO3	mg/l	280	279	278	280	281	282
12	Chlorides as Cl	mg/l	229	229	230	229	228	227
13	Sulfates as SO ₄	mg/l	68	69	69	68	67	68
14	Total Iron as Fe	mg/l	3.07	3.03	3.05	3.04	3.06	3.07
15	Silica (Reactive) as SiO ₂	mg/l	58	59	58	57	58	57
16	Sodium as Na	mg/l	65	65	64	66	67	65
17	Potassium as K	mg/l	5.8	5.7	5.6	5.5	5.9	5.8
18	Carbonate Hardness as CaCO ₃	mg/l	274	275	276	274	275	277
19	Chromium as Cr	mg/l	BDL (DL=0.1)					
20	Cadmium as Cd	mg/l	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)
21	Lead as Pb	mg/l	0.87	0.86	0.87	0.88	0.87	0.87
22	Total Arsenic as As	mg/l	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)	BDL (DL=0.1)





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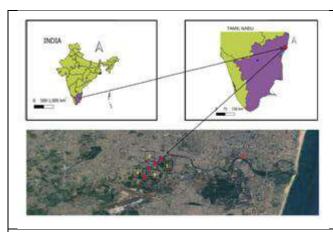


Figure 1: Water and zooplankton collection sites, including (1) Dharkast Road, (2) Anagaputur Road, (3) Cowl Bazaar, and (4) Manapakkam Bridge.

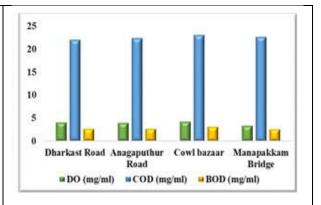


Figure 2: Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) Levels in Different Urban Aquatic Sites





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RESEARCH ARTICLE

A Survey-based Study Evaluating Covid-19 Knowledge and Awareness among the Indian Population

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ABSTRACT

People's behavior is greatly influenced by their knowledge and perceptions. This understanding and public perception significantly affect the progression of the COVID-19 pandemic. Effective prevention measures are always rooted in accurate information. The government is actively working to increase public awareness of coronavirus infection control. This survey aims to assess the awareness levels and self-protection measures adopted by individuals in both urban and rural areas. Analysis of tables and graphs revealed significant differences in knowledge between the rural and urban populations of Gurugram. Urban residents exhibited greater awareness regarding the signs, symptoms, transmission, and prevention of the coronavirus compared to their rural counterparts. The study participants demonstrated a good understanding of COVID-19. However, there remains a gap in adherence to the comprehensive guidelines issued by the government. Individuals who lacked proper education, had insufficient knowledge of COVID-19, and used information sources less frequently (weekly) were at a higher risk of contracting the disease. Therefore, it is essential for the government, universities, and hospitals to collaborate in ensuring widespread dissemination of COVID-19 information, with a particular focus on reaching rural populations and those without formal education.





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Keywords: General public, COVID 19, knowledge, prevention, and awareness

INTRODUCTION

The COVID-19 pandemic, caused by the SARS-CoV-2 virus, has proliferated globally and continues to spread. According to the World Health Organization (WHO), SARS-CoV-2, a highly transmissible and contagious virus, primarily spreads through human-to-human contact. Common symptoms include fever, fatigue, dry cough, and shortness of breath. Additionally, recent strains of the virus have been associated with seven new symptoms: muscle aches and pains, conjunctivitis, skin rashes, headaches, discoloration of fingers and toes, diarrhea, and sore throat. Most infected people show mild to moderate respiratory disease. Immuno compromised patients and patients with systemic diseases like diabetes, heart diseases, and respiratory disorder are at higher risk of mortality.3COVID-19 vaccines are now accessible in most countries, yet a significant portion of the population, particularly in rural areas, remains unvaccinated. It is imperative for those who have not yet received the vaccine to adhere strictly to the precautionary measures outlined by the World Health Organization (WHO). The most effective strategy to prevent and reduce transmission is to stay well-informed about the COVID-19 virus, the disease it causes, and its modes of transmission. There are total 194,567,100 Covid-19 casesglobally, out of which 13,792,319 are active cases and 83,975 are in serious or critical situation. Recovery rate is additionally good as 180,774,781 are closed cases in country and death rate because of covid is 4,171,596i.e. 2% of total closed cases. In India total cases are31,371,901out of which active cases are 408,178 and 8,944 are in serious condition. Recovered patients are 30,543,138. This data last updated on last updated: July 25, 2021, 12:20 GMT and sources are provided under latest news (worldometer's COVID-19 data). The COVID-19 pandemic has caused widespread concern regarding family care, future career prospects, and financial stability. This study aims to aid the general public and the health ministry in strategizing and implementing effective measures to combat the virus amidst the increasing number of cases. This original research survey seeks to evaluate the extent of exposure individuals face while commuting to their workplaces, the number of daily interpersonal contacts, the various reliable sources of information about the coronavirus within society, the proportion of people at risk, awareness of government-provided health facilities, general knowledge about the virus, its symptoms, and preventive measures. This research study cover all the above factors, hence this study will help to fight against viruses in future by designing necessary strategies in Indian society and adopting preventive measures

AIM

This study's objective was to assess and contrast the knowledge of coronavirus and the guidelines from government for the prevention of disease, in rural and urban people of Gurugram city.

MATERIAL AND METHOD

This questionnaire survey was totally based on cross sectional philosophies. We utilize logically framed 15 questions which meets the standards of the study. A total of 500, were first targeted and approached for the study, from urban and rural area of Gurugram.419 people participated in this cross- sectional survey. Patient interview was done to determine the suitability of subjects for the study. The study protocol was explained in detail to all the people. All the subjects were asked 15 questions in local language i.e., Hindi. Based on their answers the analysis was done and collected data was processed statistically to assess complications.

METHODOLOGY

The Department of Prosthodontics, Crown & Bridge, and Oral Implantology, SGT University, Gurugram carried out the current investigation. All the questions were asked only after informed consent of the individual. The distribution of characteristics of novel corona virus disease occurs more in which age group, what are the symptoms of corona





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virus and precautions to be taken for preventing the corona virus was compared between Urban and rural population using the chi-square test. Urban population had significantly more opinion that elderly were affected more, urban population was more aware about the all the symptoms of the corona virus and there was a significant difference. Medications as per doctor for treatment of corona were practiced more in urban population. Adding more garlic, ginger and other natural immunity boosters in thediet were precautions significantly more opined by rural population. Whereas covering your nose and mouth when sneezing and Wash your hands after every hour were preferred more by urban population. The awareness regarding what do you do in case of high fever and chills were compared between Urban and rural population using the chi-square test. Home Remedies was preferred significantly more by rural population. Immediately going to the hospital was preferred significantly more by urban population.

DISCUSSION

The Indian government has effectively disseminated general awareness about coronavirus. This study is a crosssectional survey conducted conveniently across India using nonprobability sampling. It aims to assess the public's general knowledge of coronavirus, with findings that could aid the Indian health ministry in formulating prevention strategies and public compliance programs. The survey focused on public knowledge of COVID-19, precautionary measures, home quarantine, and governmental interventions to curb its spread. Approximately three-quarters of survey respondents, from both urban and rural areas, demonstrated good knowledge of COVID-19, likely due to extensive media coverage and daily briefings by governmental officials. The use of nonprobability sampling was necessitated during lockdowns when movement restrictions hindered direct outreach to the entire population. This method proved efficient in terms of time and cost, leveraging platforms like Google Forms to distribute a semistructured questionnaire in Hindi via email, WhatsApp, and other social media channels. Respondents, predominantly educated middle-aged individuals (48.8% aged 20-40, 58.8% with high school education), voluntarily participated. Survey results highlighted that 59.2% understood COVID-19 primarily affects elderly individuals with underlying health conditions, while misconceptions persisted about preventive measures such as garlic consumption (15.4%) and antibiotics (11.2%). While most recognized the necessity of masks and hand sanitizers in daily life, misconceptions about their effectiveness (17.4% for masks, 23.2% for social distancing) were noted. Significant gaps were found in awareness of PPE suits (31.1%) and WHO guidelines (40.2%). Regarding healthcare utilization, 57.1% avoided hospitals unless for emergencies, while 61.1% indicated they would seek immediate medical help upon experiencing symptoms, though 21.2% believed COVID-19 could be managed at home initially. A small but notable proportion (6.7%) would delay seeking medical advice, potentially increasing infection risks for themselves and their families. Despite ongoing vaccination efforts, not all eligible individuals have been vaccinated, prompting continued government emphasis on education about the disease's causes and prevention.

CONCLUSION AND RECOMMENDATION

The awareness and understanding of coronavirus are predominantly limited to educated urban populations, as evidenced by the findings of this study. Urban dwellers are familiar with common symptoms such as fatigue, runny nose, fever, cough, sore throat, and the infectious nature of the virus through person-to-person transmission. In contrast, rural areas exhibit gaps in this knowledge, coupled with misconceptions and a false sense of security, placing them at heightened risk of contracting the virus. Healthcare infrastructure in rural India remains inadequately equipped to manage the challenges posed by COVID-19, posing significant control difficulties in these settings. However, rural areas benefit from lower population density compared to urban centers, with residents often engaged in agricultural activities, thereby reducing exposure to crowded environments. Additionally, the rural population typically enjoys higher immunity due to a diet rich in natural ingredients, reduced pollution, ample sunlight exposure, and regular physical activity. Despite these advantages, rural communities require education on recognizing symptoms, isolating symptomatic individuals, appropriate treatment protocols, and when to seek medical care. This education could be facilitated through village leaders disseminating information, healthcare





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professionals and anganwadi workers at primary health centers educating the populace, and teachers in government schools instructing children to educate their families about COVID-19. These strategies aim to enhance rural populations' understanding and preparedness in preventing and managing the disease. This article aims to assist the government in assessing the knowledge gaps between urban and rural populations, thereby guiding targeted interventions. As there is currently no definitive cure for COVID-19, prevention remains the most effective strategy. Government recommendations for COVID-19 prevention include:

- Use alcohol-based hand sanitizers or wash hands frequently with soap and water.
- Maintain at least one meter distance in public places.
- Wear double masks when social distancing is not feasible.
- Avoid touching eyes, nose, and mouth with unwashed hands.
- Cover mouth and nose with a bent elbow or tissue when coughing or sneezing.
- Stay at home and avoid unnecessary outings to public places.
- Seek immediate medical attention if experiencing symptoms of COVID-19.

CONFLICTS OF INTEREST

The authors state that this article does not involve any potential conflicts of interest.

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Table 1

Questionnaire S. No.	Variables (Questions)	Options	Responses of Patients
1	Age	1. <20years 2. 20-40 years 3.> 40 years	20-40=48.8% <20=27.8% > 40=23.4%
2	Qualification	1.Highschool	Highschool=58%



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		,	
		2. Graduate	Graduate=29.5%
		3. Post-graduate	Post-graduate=11.7%
3	Gender	1.Female	Female=50.4%
3	Gender	2.Male	Male=49.6%
4	Residence	1.Urban	Rural=52%
4	Residence	2.Rural	Urban=48%
	Which age group shows the most	1. Among children	Among elderly=59.2%
5	symptoms of the novel coronavirus	2.Among middle-aged	Among middle-aged=30.8%
	disease?	people 3. Among the elderly	Among children=10%
		1.Fever	All of the above=54.8%
		2.Cough	Fever=15.2%
6	What could be some mild symptoms	3.Difficulty in breathing	Cough=15%
	of the novel coronavirus?	4.All of the above	Difficulty in breathing=15%
		4.7 III of the above	Difficulty in breating 1370
		1.Cover your nose and	
		mouth when sneezing.	Cover your nose and mouth
		2. Include more fruits in	when sneezing.= 38.1%
		your diet.	Wash your hands every
_	What precautions are necessary to		hour=35.2%
7	avoid the coronavirus?	3. Consult your doctor	Include more fruits in your
		for antibiotic treatment.	diet=15.4%
			Consult your doctor for
		4.Wash your hands	antibiotic treatment=11.2%
		every hour.	
	Do you think that masks and hand	1.Yes	
8	washing are important to prevent	2.No	Yes=82.6%
	corona?	2.110	
9	Do you know about PPE suits?	1.Yes	Yes=68.9%
	-	2.No	168 00.570
10	Do you practice social distancing	1.Yes	Yes=76.8%
	while going out?	2.No	
11	Have you been to a hospital in the last	1.Yes	No=57.1%
	six months?	2.No	
4-	If you went to the hospital, did you	1.Yes	24 - 64 = 94
12	get your temperature checked before	2.No	Yes=66.7%
	entering the hospital?		
13	Do you know anyone who has a	1.Yes	No=64.8%
	corona?	2.No	
14	Do you know about the new WHO guidelines?	1.Yes 2.No	Yes=59.8%
	guidennes:		Will go to the bestite!
		1.Will try home remedies.	Will go to the hospital immediately=61.1%
		2. Will get admitted to	Will try home
	What will you do if you have a fever	the hospital the next	remedies=21.2%
15	or difficulty breathing?	day.	Will get admitted to the
	of difficulty bleating:	3. Will go to the	hospital the next day=11.1%
		hospital immediately.	Will consult with family
		4. Will consult with	members for advice=6.6%
		T. WIII CONSUIT WITH	members for advice-0.070





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	family advice.	members	for	

Table:2

		Frequency	Percent
Age	20-40 years	297	72.3%
	Upto 20 years	114	27.7%
Qualification	Graduate	122	29.7%
	High School	242	58.9%
	Post-graduate	47	11.4%
Gender	Male	203	49.4%
	Female	208	50.6%
Location	ocation City		48.2%
	village	213	51.8%

Table:3

		Loca	tion		Chi- square value	p- value
		Urban	Rural	Total		
	Young age group(15-20	5	36	41	67.823	< 0.001*
Characteristics of novel corona virus	yrs)	2.5%	16.8%	10.0%		
disease occur more in the category of	Older adults (>40 yrs)	157	87	244		
what age		79.7%	40.7%	59.4%		
	Middle age group (20-40	35	91	126		
	yrs)	17.8%	42.5%	30.7%		
	Cough	14	47	61	64.037	<0.001*
		7.1%	22.0%	14.8%		
	Fever	21	41	62		
What are the symptoms of corona virus?		10.7%	19.2%	15.1%		
	Shortness of breath	14	48	62		
		7.1%	22.4%	15.1%		
	All of the above	148	78	226		
		75.1%	36.4%	55.0%		
	Add more garlic in your	10	53	63	57.069	< 0.001*
	diet	5.1%	24.8%	15.3%		
The need to take what precautions to prevent the corona virus?	Antibiotics and	37	9	46		
	medicines as per doctor for treatment	17.3%	4.9%	11.2%		
	Cover your nose and	87	70	157		
	mouth when sneezing	44.2%	32.7%	38.2%		
	Wash your hands after	91	54	145		
	every hour	46.2%	25.2%	35.3%		





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Table:4

			Location		Chi-square	p-
		Urban	Rural	Total	value	value
	No	10	61	71	39.398	< 0.001*
It is important to masks and wash hands for prevention		5.1%	28.5%	17.3%		
of Corona?	Yes	187	153	340		
	res	94.9%	71.5%	82.7%		
	No	25	103	128	60.079	
Ana very average of DDE outles?		12.7%	48.1%	31.1%		< 0.001*
Are you aware of PPE suits?		172	111	283		
	Yes	87.3%	51.9%	68.9%		
	1,,	14	82	96	55.816	< 0.001*
While leaving from house do you take care of social	No	7.1%	38.3%	23.4%		
distancing?		183	132	315		
	Yes	92.9%	61.7%	76.6%		
	No	108	127	235	0.857	0.355
Here were have to be suited in the least 6 months 2		54.8%	59.3%	57.2%		
Have you been to hospital in the last 6 months?	Yes	89	87	176		
		45.2%	40.7%	42.8%		
	NI.	51	92	143	13.224	
747	No	25.9%	43.0%	34.8%		<
Was your temperature measured in the hospital?	Yes	146	122	268		0.001*
		74.1%	57.0%	65.2%		
	No	98	168	266	37.154	
		49.7%	78.5%	64.7%		< 0.001*
Have you or your known suffered from coronavirus?		99	46	145		
	Yes	50.3%	21.5%	35.3%		
	No	48	117	165	39.210	
Versuladas assaudina assau IATI IO ani 1-11 assa		24.4%	54.7%	40.1%		<
Knowledge regarding new WHO guidelines.	Yes	149	97	246		0.001*
		75.6%	45.3%	59.9%	1	

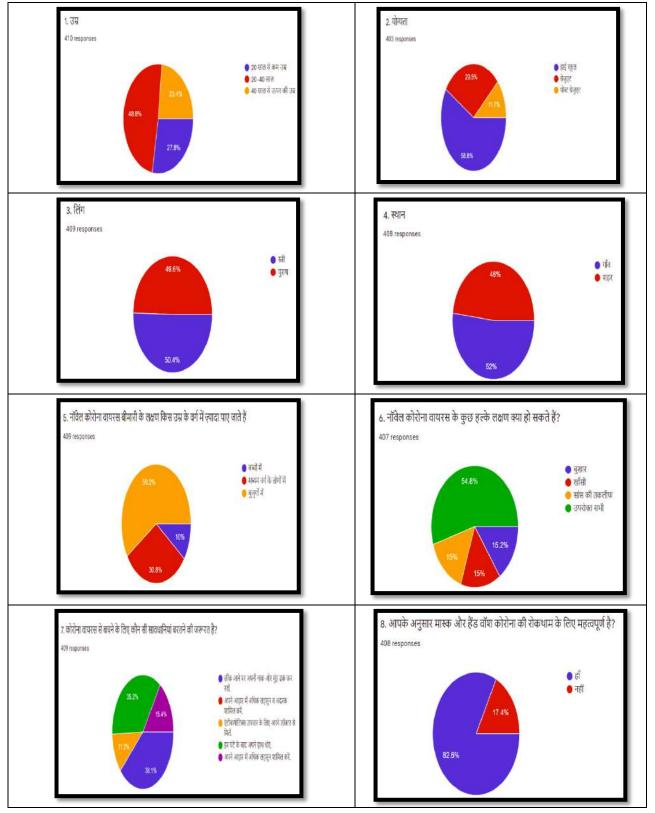
Table:5

What do you do in case of high fever and chills?		Location		Ch:	1
		Rural	Total	Chi-square value	p-value
Home Remedies		66	91	54.043	< 0.001*
Home Remedies	12.7%	30.8%	22.1%		
Immediately go to the hospital	155	93	248		
	78.7%	43.5%	60.3%		
Citting a design	8	19	27		
Sitting advice	4.1%	8.9%	6.6%		
The part day will be been italized	9	36	45		
The next day will be hospitalized	4.6%	16.8%	10.9%		





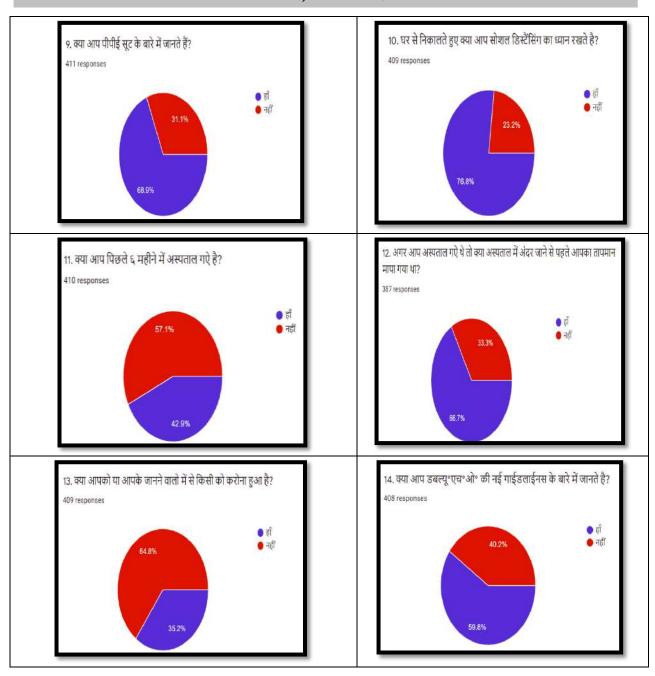
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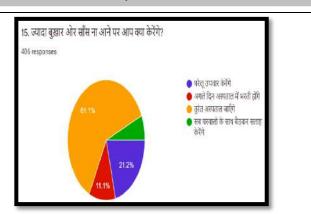


Fig 1: RESPONSES IN FORM OF PIE CHART

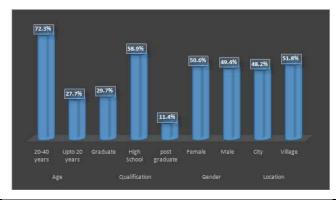


Fig:2





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RESEARCH ARTICLE

Ground Water Quality Assessment for Sustainable Drinking and Irrigation in Krishnarajapete, Mandya District using GIS

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ABSTRACT

This research paper assesses the groundwater quality in a specific study area and assesses its quality. The study uses fieldwork, laboratory analysis, and statistical modeling techniques to collect and analyze groundwater samples. The paper investigates the characteristics of the groundwater, including total dissolved solids (TDS), Electrical conductivity (EC), chloride (Cl), potassium (K), calcium (Ca), sodium (Na), magnesium (Mg), sulfate (SO₄), total hardness (TH), bicarbonate (HCO₃), pH, fluoride (F), nitrate and nitrogen (NO₃-N), iron (Fe), and Sodium Adsorption Ratio (SAR) from 30 wells in January were all analyzed as a groundwater compatibility study. The results show that the quality of groundwater in the study area is generally good, but some areas exhibit elevated levels of contaminants, such as nitrate. This study has demonstrated how well GIS, statistical analysis, and WQI work together to assess groundwater quality, providing decision-makers with an overview that will help them plan more effectively for the operation and management of groundwater. The paper has significant implications for policymakers, water resource managers, and stakeholders involved in managing and protecting groundwater resources.

Keywords: Groundwater quality; Hydrologic cycle; Hydrology; Sustainable development; Water quality index (WQI); Water resource management;





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INTRODUCTION

The primary source of water for consumption as drinking water, irrigation, and industrial applications is groundwater[1].Limiting and controlling the amount of freshwater used for agriculture has been one of the main efforts of the national and local governments to protect this essential resource for sustainable development. However, agriculture continues to be a significant part of the global economy [2,3]. The demand for groundwater has been sharply rising over the past few decades as a result of increased consumption for drinking, irrigation, industrialization, and other uses as well as the depletion of surface water supplies [4,5]. Sewage discharge, both organic and inorganic, industrial and agricultural waste, mining, fertilizers, and pesticides that are washed off the land by rain are the most common sources of groundwater pollution [6,7]. India is the residence of more people only 4% of the world's freshwater resources are available to 17% of the world's population. Except for this water shortage, groundwater is being mined illegally without taking quality concerns into account[8.9]. Studies have revealed problems with groundwater quantity (water budget deficit) and quality (pollution with deadly substances like arsenic, nitrate, fluoride, and heavy metals) in several regions of India[10].

Therefore, it is crucial to assess the quality. A typical assessment of quality is simple, but it necessitates a step-by-step procedure taking the different characteristics into account (11). To produce the key water quality index (WQI), an accumulation function was selected and presented (12). An efficient tool for managing, organizing, and analyzing spatial data for decisions in multiple locations at once is a Geographic Information System (GIS). This helps address important, fundamental issues [13]. It has successfully used GIS to show how water quality parameters are distributed. Because groundwater in the research area is primarily used for agriculture as well as for drinking water in rural and urban areas, GIS would be essential to maintaining the sustainability of the investigated quality of the aquifer. Consequently, to better comprehend the processes and the state of groundwater quality in the research region. Water quality in the study area is important for drinking and irrigation, and improving water quality is a major challenge. Analyzing the quality parameter is required to understand the current situation in the area of study.

Materials and Methods

During the pre-monsoon season, thirty groundwater samples were taken from the different bore wells in the research area. The places where the samples were taken were marked. The samples were collected after five minutes of pumping and maintained at 4° C in meticulously cleaned polythene containers until the start of the chemical analysis. Calcium (Ca), sodium (Na),magnesium (Mg), chloride (Cl), sulphate (SO4), and potassium (K) concentrations were measured in the lab by volumetric titration techniques, and chloride concentrations were determined using auto titrate. Sulphate content was measured using a flame-photometer (Model No. 128) and sodium and potassium contents with a spectrophotometer (Model No. 119). The accuracy of the analyses was routinely checked using blanks and standards. To guarantee that the outcomes were accurate to within 5%, the ion balance error was also determined. WATCHIT software, data were analyzed using it. The thematic maps were produced using ARC GIS version 10.8.

Study Area

The study area Krishnarajapete situated in the Mandya district of Karnataka state extends between longitude 76°19′47″ E and latitude 12°27′04″ N with an area extent of 896 Sq. km comes under Toposheets number 57D/5, 57D/6, 57D/9, 57D/12, and 57C/16 which was published by Survey of India(SOI) shown in Fig 1. Krishnarajapete taluk enjoys a tropical climate with an annual rainfall of 651mm. The area under study is identified as a semi-arid region. The temperature is usually in the range of 19°-35° C. The Krishnarajapete taluk summer is during February-May and the Rainfall season is in June – September.Paddy, sugarcane, and Ragi are the major crops. The major rivers are Cauvery, Hemavathy, Shimsa, and Lokapavni[14]. The blue color indicates the study area in map 1.





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Water Quality Index (WQI Index)

Horton was the first to represent the quality of groundwater using indices [15]. The Water Quality Index (WQI) is one of the many instruments available for displaying data on the nature of water [16]. A rating system known as WQI is used to show how different parameters affect the general quality of water [17]. It serves as a crucial marker for the assessment and management of groundwater in that capacity. WQI is evaluated in light of how suitable the groundwater is for human use. Later, Brown et al. (18) developed the idea. The following is how the arithmetic weighted water quality index (WQI) is displayed:

$$QI = \sum_{i=1}^{n} WiQi / \sum_{i=1}^{n} Wi$$

$$\tag{1}$$

where n is the number of factors or parameters, Wi is the parameter's unit weight, and Qi is the parameter's quality rating (sub-index). The suggested standards for each water quality parameter are inversely correlated with the (Wi) unit weight of the relevant parameter.

$$Wi=K/S_n$$
 (2)

where Wi is the unit weight for the ith parameter, Sn is the standard value for the ith parameter, and K is the constant of proportion, Using the aforementioned equation, the value of K is calculated here as "1".

$$K=1/\sum \left(\frac{1}{s_n}\right) \tag{3}$$

The following equation is used to determine the sub-index or quality rating's value. (Qi):

$$Qi = 100[(V_0 - V_i)/(S_n - V_i)]$$
(4)

Where V_0 is the parameter's actual value as measured at a particular sampling location, V_i is its ideal value in pure water, and S_n is its maximum allowable value.

For drinking water, all ideal values (Vi), except pH and oxygen that is dissolved, are taken to be zero(19). For natural water, the pH value is 7.0, but contaminated water can have a pH of up to 8.5. Similar to dissolved oxygen, the normal acceptable amount for drinking water is 5 mg/L but the optimal value is 14.6 mg/L. As a result, the formulae are used to determine the quality grade for pH as well as Dissolved Oxygen, respectively, as shown below:

$$Q_{\text{pH}} = 100[(V_{\text{pH}}-7.0)/(8.5-7.0)]$$

$$Q_{\text{do}} = 100[(V_{\text{do}} 14.6)/(5/0-14.6)]$$
(5)

Where VpH is the observed pH value and Vdo is the observed dissolved oxygen value. The standard values are shown in Table 1.

Irrigation Water Quality Indices (IWQIs)

The quality of the irrigation water is determined by the type and quantity of dissolved substances present. In general, the quality of irrigation water is assessed using, trace element toxicity, specific ion toxicity, and sensitive cropother effects. The following parameters are calculated for IWQI

Sodium percentage (SP) Na% =
$$[(Na^{2+} + K^+)/(Ca^{2+} + Mg^{2+} + Na^{2+} + K^+)] \times 100$$
 [21]
Soluble Sodium Percentage SSP= $[Na^{2+}/(Ca^{2+} + Mg^{2+} + Na^{2+})] \times 100$ [21]
Sodium Adsorption Ratio SAR= $(Na^+/\sqrt{Ca^{2+} + Mg^{2+}}) \times 100$ [22]





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Kelly's Ratio $KI = Na^{+}/(Ca^{2+} + Mg^{2+})$ [23]

Permeability Index PR= $[(Na^{2+} + \sqrt{HCO_3^-})/(Ca_{2+} + Mg^{2+} + Na^{2+})] \times 100$ [24] Magnesium Adsorption Ratio MAR= $[Mg^{2+}/(Ca^{2+} + Mg^{2+})] \times 100$ [25]

Residual Sodium Carbonate $RSC = (HCO_3^{2-} + CO^{3-}) - (Ca^{2+} + Mg^{2+})$ [26]

Residual Sodium Bicarbonate RSBC= (HCO₃²⁻- Ca²⁺) [27]

All the above IWQI was calculated indices in meq/L.

RESULTS AND DISCUSSIONS

EC, TDS, and pH

The pH ranged from 6.64 to 8.29 in 30 samples, with an average pH of 7.51. The water samples' electrical conductivity (EC) ranges from 407 to 3280 S/cm. TDS readings are thought to be crucial factors in deciding how much water to use. Total dissolved solids (TDS) concentrations range from 203 to 1640 mg/l, the average TDS was determined to be 352.55 mg/l, Cl ranges from 31.33 to 471.91 mg/l, HCO₃62.29 to 273.56 mg/l, CO₃ranges from 0.01 to 1.14 mg/l, SO₄15.65 to 145.06, Na ranges from 22.9 to 380 mg/l, and K ranges from 06 to 79.3 mg/l within the limit of drinking water standard. Mg concentration ranging from 16.03 to 125.38 mg/L only in one location mg was richer than the standard, Ca values from 49.6 to 271.2 mg/L only in two places richer than the standards, F values from 0.19 to 4.5 mg/L only in one place exceeds the maximum range, Fe ranges from 0.02 to 2.56 mg/L in 4 samples the values exceed the maximum standard value, and NO₃-N ranging from 0.41-226.59 mg/L means in three samples the values were higher than standards but the average of all parameter of drinking water values fall within the BIS standards which is substantially within the limit that makes water good for human consumption and was tabulated in Table 2[28].

Water Quality Index

Arc GIS 10.1 is used to create the water quality index (WQI) map, which uses carefully chosen quality parameters to categorize each sample of water into very poor, poor, good, and excellent for drinking. The map makes it very evident that the groundwater quality in KR Peteis good when it comes to suitability for human use. The Fe concentration which was higher than 0.3 BIS shown in 4 samples was unsuitable for human consumption shown in Table 3. The proper treatment of water from 4 samples will be useful for human consumption. Water quality and status classification using the weighted arithmetic WQI Method, with values compared in Table 4. The quality of the groundwater gradually varies from good and excellent in the center to inappropriate outside. Except for the southeastern part of the region, the quality of the groundwater is unchanged (Fig 2). The Agasarahalli, Ichanahalli, Kabbalagerepura, and Belathur samples show a high percentage of iron. Biruvalli and Iypanahallifall under poor and very poor respectively. For the most part, the groundwater quality in the study area falls into the excellent and good category, making it fit for both domestic and drinking purposes.

Irrigation water quality parameters

Salinity Hazard Classification

The salinity of water that was used for irrigation was classified into 4 categories and assigned a letter grade (Table 4). Each lesson began with a description of the highest salinity permitted, the quality of the soil for crops, the required safety precautions, and the features of the crops that must be grown [29]. As per the SAR and EC values of samples found that 8 samples fall in the S1C2 and 4 samples fall in S2C2 in low and medium salinity categories. The 13 samples fall in the C3S2 in medium to high salinity and 5 samples show high salinity as shown in Fig.3 a. This clearly shows that migration of fresh water to saline water because of rural household sewage effluents infiltration and untreated industrial wastewater etc...

The Wilcox plots help to understand the groundwater suitability for irrigation purposes shown in Fig 3 b. As per this plot, only 6 were doubtful and 2 were unsuitable out of 30 samples. It means 22 samples were fit for irrigation.





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Sodium Percentage (SP)

This sodium percentage is tabulated as per the recommended table only one sample of water was doubtful and no water samples were unsuitable for irrigation. The measuring unit for all ion concentrations is me q/l. The suitability is expressed in Table 5 and the spatial distribution map in Fig 4 a [30].

Soluble Sodium Percentage (SSP)

The contrast between the sodium concentrations and those of calcium and magnesium. When compared to Ca^{2+} and Mg^{2+} , Na^+ has a higher concentration in water, which results in toxicity compounds that damage leaves and decomposing tissue from plants [31]. The results show that all groundwater is completely safe expressed in Table 6 but in the spatial distribution map classified into three classes of safe percentages shown in Fig 4 b.

Sodium Adsorption Ratio (SAR)

To identify how the quality of water influences the characteristics and production of the crops [32]. The tables explained the range and limits 2 samples were permissible and 28 samples fall under good and excellent remarks shown in Table 7 and Figure 4 c. A value less than means low sodium water and values more than 26 mean high sodium water [33].

Kelly's Index (K.R.)

A KI number less than one (KI < 1) suggests that the water is appropriate for farming, whereas a value larger than one (KI > 1) indicates that the water has an overabundance of sodium. 93.33% of the samples were deemed acceptable as per the KI results, whereas the remaining samples 6.6% were unsuitable and summarized in table 8 and map in Fig 4d.

Permeability Index (PI)

Numerous substances, including salt, calcium, magnesium, and bicarbonate, have an impact on the permeability of the soil. Since continuous irrigation water use influences soil permeability, which is controlled by soil elements including salt, magnesium, calcium, and bicarbonate ions, the PI is a crucial indicator of the quality of irrigation water. Permeability Index is classified using this category in Table 9and Fig 4 e.

Magnesium Adsorption Ratio (MAR)

Most water maintains an equilibrium between Ca and Mg. When soils get more salinized, an excess of magnesium in irrigation water will negatively impact agricultural productivity. Table 10 shows that all water samples were suitable for irrigation and spatial distribution was classified into three classes as shown in Figure 4 f.

Residual Sodium Carbonate (RSC)

High RSC has the potential to adversely affect the physical qualities of the soil by causing the organic matter to dissociate, which leaves a black stain on the surface when the soil dries. Results were tabulated in Table 11 shows use of 29 samples was safe as per irrigation water and spatial distribution map in Fig 4 g.

Residual Sodium Bicarbonate (RSBC)

The water has a high RSBC and pH. farming with such water has stopped producing crops resultingin the accumulation of sodium carbonate. Residual sodium bicarbonate concentrations in the research areashow 28 places where water samples fall under the normal water range and 2 samples were low alkalinity range shown in Fig 4 h and Table 12.





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CONCLUSIONS

This investigation sheds light on whether the aquifer is suitable for irrigation and drinking. The physicochemical features of WQIs, IWQIs, and GIS approaches were utilized to identify the different groundwater hydrogeochemical kinds and their regulating mechanisms. The hydrochemical facies showed reverse ion exchange, according to the physicochemical parameters that were obtained, evaporation/crystallization, and rock water interaction were the main hydrochemical processes that governed the chemistry of the groundwater in the complex term aquifer. Even though human groundwater pollution may affect salinity discovered in the current inquiry, after all the parameters were examined, the majority of water samples were found to be safe for irrigation and drinking.

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Conflict of interest

There is no conflict of interest among authors.

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Table: - 1 Water quality and status classification using the weighted arithmetic WQI Method (20).

WQI	Rating Class
0–25	Excellent
26–50	Good
51–75	Poor
76–100	Very Poor
>100	Unsuitable





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Table 2. A statistical assessment of the groundwater's chemical and physical characteristics in 30 samples at the KR Pete region.

Parameters	Unit	Min	Max	Mean	BIS Standards
pН	-	6.64	8.29	7.51	6.5-8.5
EC	μS/cm	407	3280	705.72	-
TDS	Mg/L	203	1640	352.55	500-2000
Cl	Mg/L	31.33	471.91	112.04	250-1000
HCO ₃	Mg/L	62.29	273.56	106.64	200-600
Ca	Mg/L	49.6	271.2	68.17	75-200
Mg	Mg/L	16.03	125.38	28.98	30-100
SO ₄	Mg/L	15.65	145.06	33.07	200-400
F	Mg/L	0.19	4.5	0.44	1-1.5
Fe	Mg/L	0.02	2.56	0.03	1
NO ₃ -N	Mg/L	0.41	226.59	8.67	45-100
Na	Mg/L	22.9	380	50.70	-
K	Mg/L	0.6	79.3	3.43	-

Table 3. The study area's groundwater classification is based on WQI.

Sl.no.	NAME	WQI Values	Remarks
1	SHILENERE	20.90648	Excellent
2	RAJAGHATTA	20.17778	Excellent
3	AGASARAHALLI	632.42785	Unsuitable
4	KR PETE	19.54649	Excellent
5	HANCHEMUDDENAHALLI	29.93975	Good
6	LAXMIPURA	48.74344	Good
7	KOMMENAHALLI	20.66385	Excellent
8	AKKIHEBBAL	16.38125	Excellent
9	BIRUVALLI	73.09035	Poor
10	MALLENAHALLI	34.77764	Good
11	KARIGANAHALLI	25.09629	Good
12	ICHANAHALLI	506.87891	Unsuitable
13	BOOKANKERE	18.51747	Excellent
14	CHIKKAGADIGANAHALLI	43.92582	Good
15	KATTEKYTHANAHALLI	13.00647	Excellent
16	SOMANAHALLI	18.81031	Excellent
17	IYPANAHALLI	90.46935	Very Poor
18	KIKKERI	22.52925	Good
19	DEVARAHALLI	27.64388	Good
20	AANEGOLA	35.52457	Good
21	CHIKKTARAHALLI	22.15775	Excellent
22	UGINAHALLIKOPLU	21.91062	Excellent
23	MAADAPURAKOPLU	45.61986	Good





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24	KABBALAGEREPURA	200.0817	Unsuitable
25	MARUKANAHALLI	27.76745	Good
26	GANJIGERE	27.2651	Good
27	POOVANAHALLIKOPLU	37.77088	Good
28	AALAMBADI KAVLU	39.92101	Good
29	S-PURA	26.69635	Good
30	BELATHUR	383.15515	Unsuitable

Table 4. Water quality and status classification using the weighted arithmetic WQI Method, with values compared to study area samples.

WQI	Rating Class	No. of Samples
0–25	Excellent	10
26–50	Good	14
51–75	Poor	1
76–100	Very Poor	1
>100	Unsuitable	4

Table 5. Sodium Percentage classification

Range	Remarks	No. Samples
<20	Excellent	1
20-40	Good	19
40-60	Permissible	9
60-80	Doubtful	1
>80	Unsuitable	-

Table 6. Soluble Sodium Percentage classification

Range	Remarks	No. Samples
<60	Safe	30
>60	Unsafe	-

Table 7. Sodium Adsorption Ratio classification.

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Range	Remarks	No. Samples	
<10	Excellent	20	
10-18	Good	8	
18-26	Permissible	2	
>26	Doubtful	0	

Table 8. Kelly's Ratio classification

Range	Remarks	No. Samples
<1	Suitable	28
>1	Unsuitable	2





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Table 9. Permeability Index

Range	Remarks	No. Samples
<25	UnSuitable	0
25-75	Good -class ll	28
>75	Goog- class 1	2

Table 10. MAR Classification of groundwater samples from the study area.

Range	Remarks	No. Samples
<50	Safe	30
>50	Unsafe	-

Table 11. Residual Sodium Carbonate of groundwater samples from the study area.

Range	Remarks	No. Samples
>2.5	Unsuitable	1
1.25-2.5	Marginal	-
<1.25	Safe	29

Table 12. RSBC Classification of groundwater samples from the study area.

Range	Remarks	No. Samples
<1	Non alkaline water	-
0-1	Normal water	28
1-2.5	Low alkalinity water	2
2.5-5.0	Medium alkalinity water	-
5.0-10.0	High alkalinity water	-
>10.0	Very high alkalinity water	-

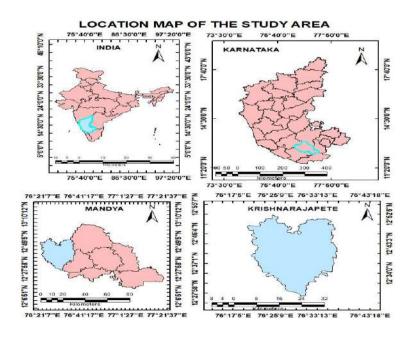


Fig 1. Location Map of Study Area



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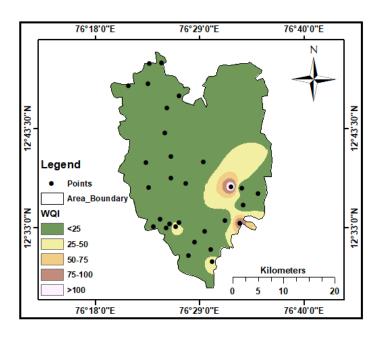


Fig 2. Spatial distribution map of Water quality index (WQI)

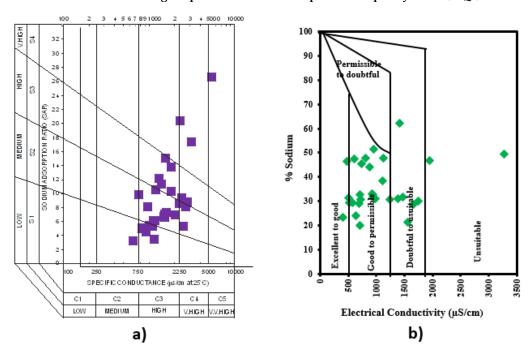
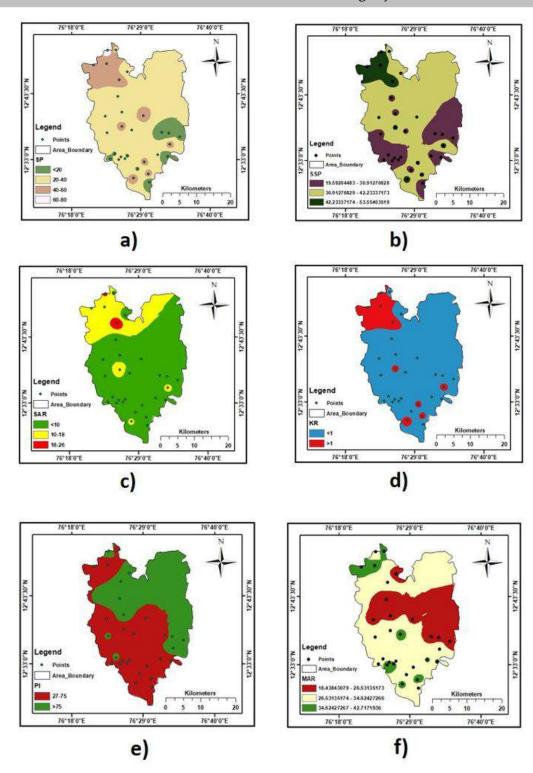


Fig 3. a) U.S.S.L. diagram showing the groundwater sample quality for irrigation in the study area (U.S.S.L.S., 1954) and b) Wilcox illustration showing the quality of irrigation water (after Wilcox, 1955)











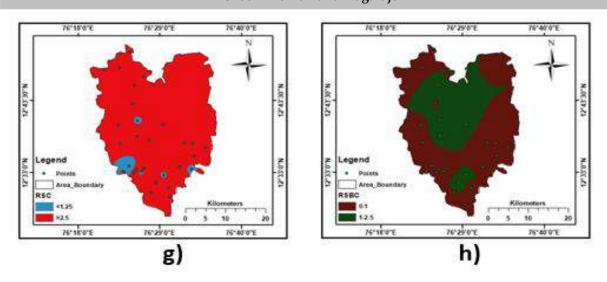


Fig 4. Spatial distribution of a) SP, b) SSP, c) SAR, d) KR, e) PI, f) MAR, g) RSC, and h) RSBC.





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RESEARCH ARTICLE

Growth and Yield Analysis of Kasuri Methi (Trigonella corniculata L.) under Multiple Organic Manure Module

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ABSTRACT

A field experiment was planned and conducted during 2021-22 at Horticulture Research Block, School of Agriculture Sciences, SGRRU, Dehradun, Uttarakhand to analyze the growth and yield of kasurimethi (Trigonellacorniculata L.) under multiple organic manure". The experiment was laid out in randomized block design with three replications and ten treatments. The treatments comprised following levels of different organic manures with different concentrations viz. T1 (Control), T2 (Vermicompost @5 t/ha), T₃(FYM @10 t/ha), T₄ (Vermiwash @50%),T₅(cow urine @50%), T₆ (Rhizobium @500 ml/ha), T₇(Vermicompost @ 2.5 t/ha + FYM @5 t/ha), T₈(Vermicompost@2.5 t/ha + FYM @5 t/ha+ Vermiwash @25%), T₉(Vermicompost @2.5 t/ha + FYM @5 t/ha+ Vermiwash@25%+Cow urine @25%)and T₁₀(Vermicompost @ 2.5 t/ha + FYM @5 t/ha+Vermiwash @25%+Cow urine @25%+Rhizobium @250 ml/ha). Observations on various growths and yield attributes were recorded. Of all the organic treatments T₇of soil application with VC @5t/ha +FYM @10t/ha has shown the significant improvement in growth and yield parameters than other treatments. The treatment T₇(VC @5t/ha +FYM @10t/ha) recorded the highest in plant height (12.66cm), number of leaves/plants (30.80), total fresh weight plant (9.71g), total dry weight plant (2.44g), number of inflorescence per plant (26.33), number of pod per plant (25.80), pod length (2.04cm), number of seeds per pod (4.40), leaf yield (t/ha) and seed yield (q/ha). Whereas, leaf width (2.18) was observed maximum in T₈ and leaf length (2.32cm)in T₁₀.





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Keywords: Kasurimethi, FYM, vermicompost, vermiwash, cow urine, rhizobium, seed yield

INTRODUCTION

Kasurimethi (TrigonellacorniculataL.)is a very popular leafy vegetable from the family Fabaceae (Leguminaceae) and genus Trigonella. It was named "Trigonella" from the Latin word which means "Little triangle". Kasurimethi is an herbaceous, bushy and slow growing annual spice crop which is native to the Mediterranean. It is popularly called as sickle fruit fenugreek in English. Kasurimethi is a self-pollinated diploid species with chromosome number of 2n = 16. It takes 5-10 days to germinate (Babaleshawaret al. 2020). The morphology of kasurimethi seed is different from the common methi. The taste of fenugreek is slightly bitter in taste but when added to the dishes, its flavour disperses and blends thoroughly in the dishes. India is one of the major producer and consumer of methi as it is used as culinary as well as for the medicinal purposes (Ahmadet al. 2016). The methi seeds are used as condiments and for adding flavour to the food. Both the green leaf and seeds of methi is used as flavouring agent, color and texture of the food. Presently kasurimethi is mainly cultivated in North India state only and it is an important spice crop which is mainly grown as Rabi season crop. Perhaps the cultivation is more or less similar to the common methi (Chaudhary and Chaudhary 2019). However due to its high increase in usage and assured remuneration, this spice has to expand its area and its production in other state of India. One of the major reasons which cause losses in yield and poor quality of the kasurimethi seed is due to improper nutrient management of the fenugreek (Snehlata and Payal 2012). So, giving proper integrated nutrient management approach to the kasurimethi could possibly increase the yield and the good quality seed of the fenugreek. The indiscriminate and continuous application of chemical fertilizers can cause soil and environmental degradation and also increases the cost of cultivation of the crop. Hence, a lot of importance is given to organic manures and bio fertilizers which involve supplying of nutrient requirements. The organic manures and bio fertilizers helps not only in increasing the yield but also in maintaining the soil health and provides eco-friendly environment.

MATERIALS AND METHODS

The present experiment was conducted at Horticulture Research Block, Department of Horticulture, School of Agricultural Sciences, Shri Guru Ram Rai University, PathriBagh, Dehradun, Uttarakhand, during the year 2021-2022. The experiment was laid out in randomized block design with three replications and ten treatments. The treatments comprised following levels of different organic manures with different concentrations viz. T₁ (Control),T₂ (Vermicompost @5 t/ha), T₃ (FYM @10 t/ha), T₄ (Vermiwash @50%), T₅(cow urine @50%), T₆ (Rhizobium @500 ml/ha), T₇ (Vermicompost @ 2.5 t/ha + FYM @5 t/ha), T₈ (Vermicompost@2.5 t/ha + FYM @5 t/ha+ Vermiwash @25%), T₉ (Vermicompost @2.5 t/ha + FYM @5 t/ha+ Vermiwash @25%+Cow urine @25%) and T10(Vermicompost @ 2.5 t/ha + FYM @5 t/ha+ Vermiwash @25%+Cow urine @25%+Rhizobium @250 ml/ha). The Kasurimethi seed was used for research purpose. The sowing was done on November 15th, 2021. All the growing media i.e., vermicompost, FYM, vermiwash, cow urine and rhizobium were prepared according to the treatments. All the cultural practices were done at regular intervals as per the requirement of crop during the period of experiment. During the research trial, from each replication five randomly selected plants were used for recording the various observations on growth and yield parameters at the interval of 30, 60 DAS and at Final harvest stage. Studies on vegetative and yield attributes were recorded using standard method of measurements. The obtained data were subjected to the statistical analysis by adopting analysis of variance technique as described by (Gomez and Gomez 1996) for the Randomized Block Design.





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RESULTS AND DISCUSSION

The various growth and yield parameters like plant height (cm), number of leaves, leaf length (cm), leaf width (cm), number of inflorescence, number of pod per plant, pod length (cm),leaf yield and seed yield were significantly influenced by different doses of organic manures as compared to control during the course of investigation. The data presented in Table-2, 3 and 4 were showed that the significant improvement was noticed when applied different combinations of growing media on fenugreek as compared to control. The findings of the present investigation were recorded and are thoroughly discussed below:

Plant height (cm)

At 30 days the maximum plant height was recorded in treatment T_{10} (5.12cm) with the combination of VC @ 2.5t/ha +FYM @5t/ha+VW @25%+CU @25%+Rhizobium @250 ml/ha and it was at par with T_{9} (4.92cm) and T_{8} (4.89cm). However, significant differences were observed with treatment T_{4} (4.46cm) and T_{2} (4.29cm). The minimum plant height was recorded in T_{1} (3.91 cm) under control condition. At 60 DAS the highest plant height (12.38 cm) was recorded in T8 with VC @ 2.5t/ha +FYM @5ton/ha+ VW @25% which was at par with T_{10} (12.21cm). The significant difference was recorded with treatment T4 (11.31cm), T6 (11.25cm), T3 (10.74 cm) and T2 (10.09cm). The minimum plant height was recorded in T_{1} (9.02 cm) under control condition. At final harvest the highest plant height was recorded in T_{1} (21.24 cm) with VC @2.5t/ha + FYM @ 5t/ha. While, the minimum plant height was recorded in T_{1} (13.97 cm) under control condition. This might be due to optimum dosage and beneficiary effect of organic manures. The growth promoting effect of vermicompost and FYM as a source of plant nutrients and humus, improves physiological condition of the soil in terms of good aeration. Similar observation was also reported by (Sunanda*et al.* 2020 and Mehta *et al.* 2010).

Number of leaves per plant

Data regarding the effect of different organic manures on number of leaves per plant at 30, 60 DAS and at final harvest has been presented in Table 2 and Fig 2.At 30 DAS, the number of leaves was maximum in $T_{10}(11cm)$ which was comparable with T_{9} (10.90cm) and T_{7} (10.23cm). However, treatment T_{8} (9.90cm), T_{5} (9.40), T_{4} (8.97cm), T_{2} (8.80cm) and T_{3} (8.97cm) are at par with each other. While, minimum number of leaves was obtained in the treatment T_{1} (7.67cm) under control condition. In case of 60 DAS, the number of leaves was maximum in T_{9} (31.13 cm) which was comparable with T_{7} (30.33cm) and T_{8} (29.27 cm). However, treatment T_{3} (25.27cm), T_{4} (26.20 cm)and T_{1} (25.47cm) are at par with each other. While, minimum number of leaves was obtained in the treatment T_{2} (24.93 cm). At final harvest, number of leaves per plant was found maximum in T_{7} (30.80 cm) with the combination of VC @2.5 ton/ha+FYM @5 ton/ha and the minimum number of leaves per plant was recorded in the treatment T_{2} (27.93 cm) under vermicompost condition. The result is in close conformity with report of (Biswas and Anusuya 2014).

Leaf length (cm)

The observation of leaf length was recorded at 30 DAS, 60 DAS and at final harvest and the results shows significant differences between the treatments. At 30 DAS, the highest leaf length was recorded in treatment T₆(1.49 cm) and the lowest (1.36 cm) of leaf length was recorded under the treatment T₂vermicompost.In 60 DAS, the maximum leaf length was recorded in treatments T₉(1.95 cm) and the minimum leaf length (1.48 cm) was recorded under the treatment T₁ under control condition. At final harvest, the leaf length was maximum in T₁₀(2.32 cm). However, there were no significant difference was recorded in treatment T₂(2.15 cm), T₃(2.23 cm), T₄(2.23 cm), T₅(2.11 cm), T₆(2.24 cm), T₇(2.24 cm), T₈(2.26 cm) and T₉ (2.24 cm). While minimum leaf length was recorded in the treatment T₁ (1.99 cm). The application of VC @2.5t/ha + FYM @5t/ha + Vermiwash@25% + cow urine@25% +Rhizobium@250 ml/ha increases the leaf length which might be due to application of major and minor nutrients, through different organic manures in various levels, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately increases the leaf length. The findings are also in agreement with the findings of (Dhara*et al.* 2018 and Godara*et al.* 2012).





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Leaf width (cm)

The leaf width on 30 days after sowing differs significantly and was ranging from 1.23 cm to 1.47cm. The maximum leaf width was recorded in $T_1(1.47cm)$ with control condition and the minimum leaf width was recorded in the treatment $T_2(1.23cm)$ under vermicompost. In 60 days after sowing, the maximum leaf width was recorded in $T_2(1.77cm)$ under vermicompost. While, the minimum leaf length was obtained in the treatment $T_{10}(1.6 cm)$ under the combination of VC @ 2.5t/ha +FYM @5ton/ha+VW @25%+ CU @ 25%+Rhizobium @250ml/ha. There were no significant differences observed among the treatments. However, at final harvest, the data showed that leaf width of different treatments ranged from 1.63 cm to 2.18 cm. The maximum leaf width was recorded in $T_8(2.18 cm)$, which was found at par with treatments $T_4(2.01cm)$ and $T_7(2.06 cm)$. The minimum leaf width was recorded in the treatment $T_1(1.63 cm)$ under control condition. This might be due to the continuous nutrient availability by the use of organics. This is found to be in accordance with findings of (Meena*et al.* 2018; Singh and Saxena 2020).

Total Fresh weight of plant (g)

The maximum total fresh weight of plant (9.71g) was recorded in T₇ (VC 2.5t/ha + FYM 5t/ha). The minimum total fresh weight of plant was recorded in control T₁ (3.91g). The results show significant differences between the treatments. The increase in total fresh weight of plant may be due to the application of balanced nutrients in integrated sources which promote better photosynthetic activity resulted in increased carbohydrate synthesis and better plant growth. Similar results were obtained by (Pushpa*et al.* 2012).

Total dry weight of plant (g)

The maximum dry weight of plant (2.44g) was recorded in T_7 (VC 2.5t/ha + FYM 5t/ha), which was found at par with T_9 (1.99g) while, minimum fresh weight of plant (0.66g) was recorded under treatment T_1 control. The results show significant differences between the treatments. The increase in total dry weight of the plant may be due to the excellence of high level of organic manures was producing good growth in plants which show higher dry weight of the plant. The findings are in similar with (Malavet al. 2018).

Number of inflorescence per plant

The results revealed that the number of inflorescence recorded at the time of flowering was affected significantly by different combinations organic manure. The highest number of inflorescences per plant was recorded in T_7 (26.33), which was par with T_5 (24.47) indicating significantly superior to all other treatments. The lowest number of inflorescences recorded in T_1 (12.67) under control condition. The findings are in similar with (Malik and Tehlan 2009) on fenugreek.

Number of pods per plant

The highest number of pods per plant was recorded in T_7 (25.80) with VC 2.5t/ha + FYM 5t/ha and the lowest number of pods was recorded in T_6 (16.77) under rhizobium condition which might be due to the application of balanced nutrition through different organic sources resulted in increased vegetative growth and synthesis of relatively more amount of food materials and photosynthates were translocated and accumulated in the reproductive parts, led to maximum number of pods per plant. The results of the present study are comparable with (Singh *et al.* 2020 and Khiriya*et al.* 2022) in fenugreek.

Pod length (cm)

The highest length of pod per plant was recorded in T_7 (2.04cm) with VC 2.5t/ha + FYM 5t/hamight be due to the same treatment registered maximum leaf area resulted in better photosynthesis, led to more accumulation of photosynthates in pod. This result was in conformity with the findings of (Kauser *et al.* 2018).





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Number of seeds per pod

The highest number of seeds per pod was recorded in T₇ (4.40) through VC 2.5t/ha + FYM 5t/hamight be due to the same treatment registered maximum leaf area resulted in better photosynthesis, led to more accumulation of photosynthates in pod. This result was in similarity with the findings of (Chandan*et al.* 2021) in fenugreek.

Leaf yield (Kg/plot)

The leaf yield (0.97 kg/plot) was recorded in T_7 with VC@2.5t/ha +FYM@5ton/ha which was at par with T_{10} (0.81kg/plot) and significantly superior to all other treatments. The lowest leaf yield was recorded in control T_1 (0.29 kg/plot). The results show significant differences between the treatments. This result was in agreement with the findings of (Deora*et al.* 2009 andSingh*et al.* 2010).

Leaf yield (tons/ha)

The maximum leaf yield (9.66 t/ha) was recorded in T_7 with VC @ 2.5t/ha +FYM @5ton/ha which was at par with T_{10} (8.10 t/ha) and significantly superior to all other treatments. The lowest leaf yield was recorded in control T_1 (2.9 t/ha). This result was in conformity with the findings of (Datta 2011and Jawarkar*et al.* 2016).

Seed yield (Kg/plot)

The highest seed yield (0.11Kg/plot) was recorded in T₇with VC@ 2.5t/ha+FYM@5ton/ha which was at par with T₁₀(0.09Kg/plot)VC@2.5t/ha+FYM @5ton/ha+V@25%+CU@25%+Rhizobium@250ml/ha and significantly superior to all other treatments. However, the lowest seed yield was recorded in control T₁ (0.07Kg/plot). The results show significant differences between the treatments and in agreement with (Bhati 2005 and Vasudevan*et al.* 2008).

Seed yield (q/ha)

The highest seed yield (10.14q/ha) was recorded in Trwith VC @ 2.5t/ha +FYM @5ton/ha which was at par with $T_9(9.36q/ha)$ and significantly superior to all other treatments. Whereas, the lowest seed yield of fenugreek was recorded in control T_1 (7.32q/ha). This might be due to the same treatment registered maximum seed yield per plant over other treatments. Moreover it was due to the application of optimum quantity of different nutrient sources improved soil physical, chemical and biological properties resulted in higher fertilizer use efficiency, ultimately led to more seed yield. Similar results were also reported by (Thakral*et al.* 2006 and Yugandhar *et al.* 2014).

CONCLUSION

On the basis of present experimental research on analysis of growth and yield of kasurimethi (*TrigonellacorniculataL.*) under multiple organic manure module, it can be concluded that among different organic manures treatments, the combination of treatment (T₇) i.e. VC @ 2.5t/ha +FYM @5ton/hawas found to be most effective for increasing plant height (cm), number of leaves (cm), total fresh weight of plant (g), total dry weight of plant (g), number of inflorescence per plant, number of pods per plant, pod length (cm), number of seed per pod, leaf yield (t/ha) and seed yield (q/ha). Whereas, T₈ treatment combination of VC @ 2.5t/ha +FYM @5ton/ha + VW @25% show effective increased in leaf width (cm). While, treatment T₁₀ was found to be most effective forincrease in leaf length.

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Table 1: Treatment Details

Treatment	Combinations	Concentration
T1	Control	-
T2	Vermicompost (VC)	5 tons/ha
Т3	FYM	10 tons/ha
T4	Vermiwash (VW)	50%
T5	Cow urine	50%
Т6	Rhizobium	500 ml/ha
T7	VC+FYM	2.5 ton/ha+2.5 ton/ha
Т8	VC+FYM+VW	2.5+2.5 ton/ha +25%
Т9	VC+FYM+VW+CU	2.5+2.5 ton/ha +25%+25%
T10	VC+FYM+VW+CU+Rhizobium	2.5+5ton/ha+25%+25%+250 ml/ha

Table 2: Effect of multiple organic manures on plant height (cm), number of leaves, leaf length (cm) and leaf width (cm) of kasurimethi at different harvest intervals

width (cm) of kasurimethi at different harvest intervals																
Treatm ent	Plant height (cm)				Number of leaves			Leaf length (cm)			Leaf width (cm)					
	30 D AS	60 D AS	At Final Harvest	Me an	30 D AS	60 D AS	At Final Har vest	Me an	30 D AS	60 D AS	At Final Har vest	Me an	30 D AS	60 D AS	At Final Har vest	Me an
T ₁	3.9 1	9.0 2	13.97	8.9 7	7.6 7	25. 47	28.20	20. 45	1.4 5	1.4 8	1.99	1.6 4	1.4 7	1.7 2	1.63	1.6 1
T ₂	4.2 9	10. 08	16.56	10. 31	8.8	24. 93	27.93	20. 55	1.3 6	1.5 4	2.15	1.6 8	1.2 3	1.7 7	1.86	1.6 2
Тз	4.5 3	10. 74	16.46	10. 58	8.9 7	25. 27	28.40	20. 88	1.3 9	1.7 3	2.23	1.7 8	1.3	1.7 6	1.92	1.6 6
T ₄	4.4 7	11. 31	17.13	10. 97	8.9 7	26. 20	28.80	21. 32	1.4 5	1.7 3	2.23	1.8 0	1.3 7	1.6 1	2.01	1.6 6
T ₅	4.6 3	11. 75	17.30	11. 23	9.4 0	27. 73	28.80	21. 98	1.4 5	1.8 5	2.11	1.8 0	1.3 5	1.6 2	1.87	1.6 1
T ₆	4.7 1	11. 25	18.76	11. 57	9.9 0	27. 87	29.00	22. 26	1.4 9	1.9 0	2.24	1.8 8	1.3	1.6 3	1.93	1.6 3
T ₇	4.7 2	11. 63	21.24	12. 53	10. 23	30. 33	30.80	23. 79	1.3 9	1.8 3	2.24	1.8 2	1.4	1.7 1	2.06	1.7 3
Ts	4.8 9	12. 38	20.72	12. 66	9.9 0	29. 27	29.53	22. 90	1.4 2	1.9 1	2.26	1.8 6	1.4 3	1.6 9	2.18	1.7 7
Т9	4.9 2	12. 09	16.79	11. 27	10. 90	31. 13	29.87	23. 97	1.3 9	1.9 5	2.24	1.8 6	1.4 4	1.7 2	1.93	1.6 9
T ₁₀	5.1 2	12. 21	17.75	11. 69	11. 00	27. 67	30.60	23. 09	1.4 0	1.9 1	2.32	1.8 8	1.3	1.6	1.68	1.5 3
C.D.(P=			1.83			1	.54			1	V/A			1	V/A	





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0.05)				
SE(d) ±	0.87	0.73	0.08	0.09

Table 3: Effect of multiple organic manures on total fresh weight (g), total dry weight of plant (g), no. of inflorescence per plant, pods per plant, pod length (cm), seeds per pod, leaf yield (Kg/plot) and leaf yield (tons/ha) of kasurimethi

Treatment	Total Fresh weight of plant (g)	Total Dry weight of plant (g)	No. of inflorescence per plant	Pods per plant	Pod length (cm)	No. of Seeds per pod	Leaf yield (Kg/plot)	Leaf yield (tons/ha)
T ₁	3.91	0.66	12.67	18.20	1.28	3.27	0.29	2.90
T ₂	5.69	1.44	18.60	18.60	1.29	3.47	0.51	5.05
Т3	5.80	1.30	18.33	22.80	1.41	3.53	0.53	5.25
T ₄	7.66	0.99	22.73	22.73	1.69	3.53	0.51	5.05
T 5	7.11	1.47	24.47	24.47	1.64	3.80	0.49	4.90
T ₆	6.13	1.86	16.77	16.77	1.53	3.80	0.66	6.55
T 7	9.71	2.44	26.33	25.80	2.04	4.40	0.97	9.66
T8	8.12	1.45	16.87	24.73	1.45	3.00	0.68	6.75
T9	6.17	1.99	16.00	24.33	1.61	3.60	0.72	7.15
T ₁₀	6.30	1.22	15.33	22.37	1.78	3.67	0.81	8.10
C.D.(P=0.05)	1.07	0.21	3.19	3.28	0.20	0.46	0.09	0.91
SE(d) ±	0.50	0.09	1.51	1.55	0.09	0.22	0.04	0.43

Table 4:Effect of multiple organic manures on seed yield (kg/plot) and seed yield (q/ha) of kasurimethi

Treatment	Seed yield (Kg/plot)	Seed yield (q/ha)
T_1	0.07	7.32
T ₂	0.08	7.80
Т3	0.09	8.8
T_4	0.09	8.71
T ₅	0.08	8.45
T ₆	0.07	7.02
T ₇	0.11	10.14
T ₈	0.08	7.99
T9	0.09	9.36
T ₁₀	0.09	8.88
C.D.(P=0.05)	0.01	1.13
SE(d) ±	0.01	0.53





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RESEARCH ARTICLE

Physico-Chemical and Chemical Properties of Organically Amended Soil

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ABSTRACT

In this study, the influence of different organic manureson the growth and yield of Green gram was studied at Mukuperi village in Thoothukudi district of Tamil Nadu, South India, situated at 8.5649° latitude and 77.99100 longitude. The experiment was laid out in randomized block design with three replications. The Experiment comprised of thirteen treatments with three different manures and their combinations at three different concentrations. After the harvest of the crop, the soil samples were collected from each plot. The collected samples were subjected to various studies like Physico-Chemical, chemical properties in Laboratories. From the results of various studies it is found that the application of organic amendments will improve soil organic matter, nutrient availability and high crop productivity.

Keywords: Farmyard manure, organic amendments, Vermicompost, Poultry manure





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INTRODUCTION

Organic manures have been proven to enhance efficiency and reduce the need for chemical fertilizers, to improve the soil fertility and soil health[1]. The organic manures provides a good source of nutrients and can serve as alternative practice to mineral fertilizers for plants. In plant nutrition, manure and compost play important role, as they act directly for increasing the crop yields either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. Organic manures help to maintain physical, chemical and biological properties of soil [2]. Green gram [Vigna radiata (L.)] is an important pulse crop and an excellent source of high quality protein. It consists of about 25% protein which is almost 2.5 - 3.0 times more than the cereals. The main objective of this study was to observe the changes in pH, Electrical conductivity, N, P and K content of soil amended with organic manures and their combinations in Green gram cultivation.

MATERIALS AND METHODS

The experiment was laid out in randomized block design with thirteen treatments in three replications. The treatment of this study were Poultry manure (P), Farm yard manure (F) and Vermicompost (V) and their combinations at three different concentrations 8.5, 12.5 and 16.5 t ha⁻¹. The organic manures were applied and after 30 days of drip irrigation, Green gram was sown. After the harvest of the crop, the soil samples were collected from each plot. Soil Physico chemical properties like pH, Electrical Conductivity (EC), Nitrogen(N), Phosphorous (P) and Potassium (K) for the soil samples were analysed in the soil testing laboratory.

RESULTS AND DISCUSSION

PHYSICO CHEMICAL AND CHEMICAL PROPERTIES

pΗ

The pH values were lowest in plot amended with P+F@12.5 t ha⁻¹ and the highest valuewas found in the control. The result is in close agreement with that of [3] who reported that the application of organic amendments significantly decreased the pH value.

ELECTRICAL CONDUCTIVITY (EC)

The value of EC decreased in all the samples than the control. The plots amended with P+F@12.5 t ha⁻¹ and P+V@16.5 t ha⁻¹had their lowest values (0.22 ds m⁻¹) whereas the maximum value (1.57 ds m⁻¹) was found in control. According to [4], the minimum EC of 0.02±0.01 ds m⁻¹ was observed in organic manure applied plot and the maximum of 2.12±1.1 ds m⁻¹ in control plot.

AVAILABLE NITROGEN (N)

Due to the addition of Poultry manure, the Nitrogen content(N) in the soil had increased. The level of nitrogen content was maximum as 163.19 Kg ha⁻¹ in plot with P+F @ 12.5 t ha⁻¹ and control had the lowest value as 95.28 Kg ha⁻¹. This is in line with the findings of [5] who stated that the application of poultry manure to soil increased soil organic matter, N and P and aggregate stability.

AVAILABLE PHOSPHOROUS (P)

The Phosphorous content in the plot amended with P+F @12.5 t ha $^{-1}$ was found to be highest(45.54 Kg ha $^{-1}$) than the control. The lowest value (7.05 Kg ha $^{-1}$) was observed in the control. The results are in accordance with [6] who reported that there was appreciable build up in available P status in soil due to application of organic manures.





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AVAILABLE POTASSIUM (K)

The value of potassium (K) was high as 855.21Kg ha⁻¹ in plot with P+F@12.5 t ha⁻¹ and it was low as 157.13Kg ha⁻¹in the control plot. This was similar to [7] who reported that the plots amended withpoultry manure had higher concentration of nutrient than plots without poultry manure application.

YIELD

The yield was high in the plot with P+F@12.5 t ha⁻¹ as 1140 Kg ha⁻¹. Thus the application of organic amendment helps to increase crop yield. The result is in agreement with [8] who reported that the addition of organic manure increase crop yield.

CONCLUSION

In this study, the results revealed thatthe combination of Poultry manure and farmyard manure improved soil physico chemical and chemical properties. The application of Poultry manure in addition to Farmyard manure was found to be effective as organic manure in enhancing productivity of soil. It is therefore concluded that organic manure amended soil has influenced the various physico-chemical and chemical properties, organic matter status, nutrient availability and productivity of the crop.

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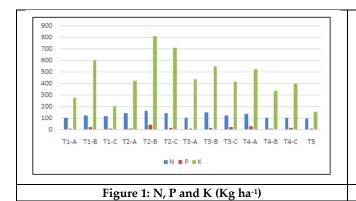


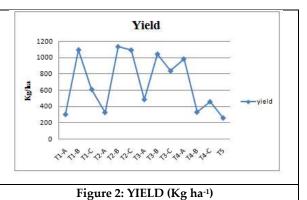
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Table 1: PHYSICO CHEMICAL & CHEMICAL PROPERTIES OF THE SOIL-AFTER HARVEST-P+(F+V):

S.No	Manure	Plots	pН	EC	N	P	K	Yield
5.NO	Manure	Piots		(ds m ⁻¹)	(Kg ha ⁻¹)	(Kg ha ⁻¹)	(Kg ha ⁻¹)	(Kg ha ⁻¹)
1.	P	T1-A	7.2	0.85	101.98	8.62	273.15	304
2.	P	Т1-В	7.1	0.47	121.11	25.76	602.51	1101
3.	P	T1-C	7.3	0.71	112.48	12.16	201.11	612
4.	P+F	T2-A	7.5	0.83	141.24	9.94	420.36	328
5.	P+F	Т2-В	7	0.22	163.19	45.54	815.21	1140
6.	P+F	T2-C	7.1	0.34	139.47	18.93	712.35	1098
7.	P+V	Т3-А	7.6	0.69	98.85	12.65	436.15	488
8.	P+V	Т3-В	7.1	0.27	145.34	14.13	548.02	1048
9.	P+V	Т3-С	7.3	0.22	121.35	22.11	418.35	840
10.	P+F+V	T4-A	7.1	0.29	131.08	27.55	521.37	988
11.	P+F+V	T4-B	7.4	0.78	100.15	11.71	337.19	332
12.	P+F+V	T4-C	7.6	0.92	98.49	19.03	398.51	460
13.	Control	T5	7.8	1.57	95.28	7.05	157.13	260

P – Poultry Manure F-Farmyard Manure V-Vermicompost EC- Electrical Conductivity N-Nitrogen P-Phosphorous K-Potassium A - 8.5 t ha⁻¹ B - 12.5 t ha⁻¹ C - 16.5 t ha⁻¹









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REVIEW ARTICLE

Overview and Applications of Amylase

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ABSTRACT

Enzymes from plants, animals, and microbes are derived from very stable and cost-effective sources. Amylase enzymes are a group of enzymes that are crucial in carbohydrate metabolism since they break down starch by hydrolysis. The enzymes are categorised into three main groups: alpha-amylase, betaamylase, and gamma-amylase. Amylase investigation involves isolating, characterising, producing, and purifying the enzyme using starch as a substrate on a small scale. Production of the amylase enzyme is energy-efficient, time-efficient, and resource-efficient. The microbial amylase enzyme is well-suited for several industrial applications such as food, biofuel, textiles, bakery, detergent, paper, and industry.

Keywords: Amylase, Enzyme, Application, Characterization, Alpha-amylase.

INTRODUCTION

Enzymes are substances that accelerate biological processes in the body and are predominantly proteins. Enzymes are predominantly utilised in the paper, food, detergent, biofuel, and textile sectors (Dixit M, et al, 2023). Natural enzymes have been utilised in the manufacturing of culinary items including beer, wine, vinegar, cheese, and more (Kirk O, et al, 2002). It also holds a 25% market share globally (Yandri Y, et al, 2022). The starch industry is a largescale sector that utilises amylase enzymes. Approximately 500 industrial goods are manufactured utilising enzymes. There is an increasing need for industrial enzymes. Microbes are among the most beneficial and abundant industrial enzymes. Various enzymes are present, such as amylase, lipase, protease, etc (Adrio J. L, et al, 2014).





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Enzymes are generated by plants, animals, and microbes. These enzymes are cost-effective to generate and stable. Amylase enzyme is the most prevalent enzyme among all enzymes. The amylase enzyme is primarily released by the salivary gland and is present in other tissues at a basic level (Akinfemiwa O, et al, 2020). Many bacteria, predominantly Bacillus species such as Bacillus subtilis, Bacillus stearothermophilus, and Bacillus amyloliquefaciens, have been identified for their ability to secrete amylase. Amylase was initially developed for industrial use over an extended period. Aspergillus niger was the initial species known to produce fungal amylase(Gopinath S. C, et al, 2017). Amylase enzyme was initially identified in the early 1800s and was the first enzyme to undergo scientific scrutiny. Amylase hydrolyzes the glycosidic link in the starch molecule, converting complex carbohydrates into simple sugars. Amylase was first discovered in 1811 by Kirchhoff. This marked the initial phase of the amylase study(Tiwari S. P, et al, 2015). There are three primary classes of amylase enzymes: alpha-amylase, beta-amylase, and gamma-amylase. 5 Alpha-amylase facilitates the breakdown of internal alpha glycosidic bonds in starch and similar polysaccharides and oligosaccharides. Beta-amylase removes the glucose molecule attached to the end of the chain. Gamma-amylase breaks the last alpha-1,4 glycosidic link at the non-reducing end of amylase. It also breaks the alpha-1,6 glycosidic link. The primary enzyme responsible for the breakdown of dietary starch in our body is alphaamylase (Li, et al, 2022). Two procedures are utilised for the manufacturing of amylase. Submerged fermentation and solid-state fermentation techniques Submerged fermentation utilises liquid substrates, such as broths, to produce end products that are discharged into the fermentation broth. Solid-state fermentation is a technique employed for cultivating microorganisms that thrive in low moisture environments. Common solid substrates utilised in this process include bran, bagasse, and paper pulp. An important benefit is that nutrient-rich waste materials may be readily recovered and utilised as substrates in this process(Suriya J, et al, 2016). Amylase enzyme is purified using several chromatography techniques and sulphate precipitation processes. Temperature and pH have a crucial role in amylase synthesis (Souza, et al, 2010).

Classification of Amylase

Amylase may be categorised into two types based on its method of action: endoamylase and exoamylase (Ahmad, et al, 2019). There are two forms: amylose and amylopectin. It consists of 20–25% starch molecules. A continuous chain of glucose units joined by alpha-1,4-glycosidic bonds, leading to the creation of an amylose chain. Amylopectin composites consist of 75–80% starch and are categorised based on the branching structure of glucose molecules. Glucose molecules are linked by alpha-1,4-glycosidic bonds in a linear configuration, with alpha-1,6-glycosidic links causing branching every 15 to 45 glucose molecules (Sundarram, et al, 2014).

Amylase Varieties

Alpha amylase

Alpha-amylase is an enzyme that breaks down internal alpha-1,4-glycosidic bonds in starch to produce glucose and maltose. It is crucial for the transformation of starch into oligosaccharides. Alpha-amylase is a calcium metalloenzyme that requires a metal cofactor to function. The ideal pH range required is 6.7 to 7.0. Alpha-amylase functions on the starch substrate. Starch is a complex carbohydrate made up of amylose and amylopectin. Amylose is composed of 20–25% starch molecules and is a linear chain made up of repeated glucose units connected by alpha-1,4-glycosidic connections. Amylopectin comprises 75-20% of starch molecules. The branched chain appears at intervals of 15–45 glucose units and contains alpha-1,6-glycosidic linkages. They are extensively utilised in the food, fermentation, textile, paper, detergent, and biopharmaceutical sectors (Souza, et al, 2010).

Beta Amylase

Beta-amylase is an exo-hydrolase enzyme that functions at the non-reducing end of a polysaccharide chain. It is also known as 1,4-alpha-D-glucan maltohydrolase, glycogenase, and saccharogen. The enzyme cannot break down branched links in branched polysaccharides like glycogen or amylopectin. The ideal pH range for its activity is 4.5 to 5.0. It can attach to the non-reducing end and facilitate the breakdown of the second alpha-1,4-glycosidic bond by





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hydrolysis. Beta-amylase is crucial in the first brewing step to generate a enough amount of maltose, the primary fermentable sugar (Souza, et al, 2010).

Gamma Amylase

Gamma-amylase breaks the last alpha-1,4-glycosidic link and the alpha-1,6-glycosidic bond in starch, producing glucose molecules. The ideal pH level required is 3.0, as they function most effectively in acidic conditions (Souza, et al, 2010).

Source of amylase from microorganisms

Amylase enzymes are generated by mammals, plants, and other microorganisms such as bacteria and fungus (Papoutsis, et al, 2021). Bacterial amylases are enzymes secreted by a wide variety of microbial species. The generation of amylase from bacteria is quicker and more cost-effective compared to other microorganisms. Bacillus species are commonly utilised for the manufacture of amylase (Gopinath S. C, et al, 2017). Fungus amylase is mostly derived from fungus species conducive to solid-state fermentation (Mafakher, et al, 2023).

Amylase's physiological functions

Submerged fermentation (SMF) and solid-state fermentation (SSF) have been studied for alpha-amylase production, with several physiochemical parameters shown to be efficient. The pH, carbon supply, nitrogen source, inoculum age, temperature, and phosphate content are crucial components of the growth medium (Gupta, et al, 2003). Amylase is stable within a pH range of 4 to 11. Organisms that make alpha-amylase thrive best around 37 degrees Celsius (Mojsov, et al, 2018).

Manufacturing Process

Submerged fermentation

Submerged fermentation is ideal for bacteria that thrive in high moisture environments. During this procedure, the substrate utilised for fermentation is consistently in a liquid condition, including the necessary nutrients for their development. Biomass is consistently collected from the fermentor by several methods. 250 ml of the flask was filled with 100 ml of sterile starch broth, inoculated with 1% standard inoculum, and incubated at 50°C on a shaker at 150 rpm for 48 to 72 hours. The medium underwent filtration, centrifugation, and drying. This enhances the synthesis of the commercial enzyme amylase. This approach offers several benefits, as the process parameters are simpler compared to solid-state fermentation. Bacterial and yeast cells are evenly dispersed in the medium (Abd – Elhalem, et al, 2015).

Solid-state fermentation procedure

Solid-state fermentation is a technique used for cultivating microorganisms that thrive with lower moisture levels. Commonly utilised substances include agricultural wastes like rice bran, black gramme bran, groundnut oil cake, and coconut oil cake. These substances are infected and incubated for 6 days at a pH of 7 and at room temperature. Nutrient-rich waste materials may be easily recycled and utilised as substrates, providing various advantages. The equipment is simpler, there is a higher concentration of products, and less effluent is produced (Suganthi, et al, 2011).

Amlyase purification method

Purification of amylase involves precipitation, liquid-liquid extraction, and chromatography methods. These procedures are utilised for achieving high levels of purity. The amylase enzyme may be purified using ammonium sulphate precipitation and subsequent dialysis. Centrifuge 100 ml of cell-free extract at 7000 rpm for 15 minutes. The supernatants are collected and subsequently saturated with ammonium sulphate to concentrations of 0–30% and 30-80%. The pellet is gathered for further examination. Various chromatography methods, including as affinity chromatography, ion exchange chromatography, and gel filtration chromatography, can be employed for the





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separation and purification of the amylase enzyme. The chromatography method used for the large-scale purification of amylase has led to efficient and cost-effective processing procedures (Sivaramakrishnam, et al, 2006).

Assessment of enzyme activity

Alpha-amylase breaks down starch into reducing sugars, making it possible to measure the enzyme's activity. Other techniques exist for assessing enzyme activity (Sundarram, et al, 2014).

Applications and Use of amylase

Paper sector

Amylase is utilised in the paper industry to substitute starch-coated paper. Coating smooths the paper's surface and enhances its writing quality (Souza, et al, 2010). Starch paste is utilised as a mounting adhesive in paper manufacture, often in conjunction with additives like protein glue or alum. Alpha-amylase may break down starch and is used either as an immersion or gel poultice to aid in its elimination (MobiniDehkordi, et al, 2012).

Industry of detergents

Enzymes mostly serve detergents. Detergents eliminate stains and are eco-friendly. Amylase enzyme serves as a secondary enzyme in the detergent industry. Amlyase enzyme is utilised in 90% of liquid detergents. Amylase aids in the elimination of stains containing starch, such as potato gravy, baby food, chocolate, pickle stain, oil stain, and others. Amylase is utilised in enzymatic detergents, with around 90% of liquid detergents include amylase enzymes (Souza, et al, 2010).

Biofuel sector

Starch is a commonly utilised substrate for ethanol synthesis and is readily available in most areas. Amylase enzyme catalyses the conversion of starch into fermentable sugar. Starches like potatoes and wheat are utilised as raw materials in the production of ethanol (Souza, et al, 2010).

Bakery Sector

Amylase enzyme is utilised in the baking business. Amylase enzyme breaks down starch into dextrins and oligosaccharides, facilitating yeast activity during dough fermentation, proving, and the early stages of baking. This leads to enhanced bread volume and texture (Sundarram, et al, 2014).

Textile sector

Amylase is utilised in the desizing process. Starch, a sizing agent, is used on yarn prior to fabric manufacturing to facilitate a rapid and stable weaving procedure. Starch is inexpensive, widely accessible, and readily removable. Amylase derived from Bacillus strain has been utilised in the textile sector for an extended period (MobiniDehkordi, et al, 2012).

Foodsector

The food business saw changes throughout its evolution. Enzymes from genetic engineering have been safely utilised in the food sector. Amylases are utilised in the processed food sector, specifically in baking, fruit juice production, and starch syrup manufacturing (MobiniDehkordi, et al, 2012).

CONCLUSION

Amylase enzymes are enzymes that break down starch and have various functions in different biological areas. Amylase is an enzyme that facilitates the breakdown of starch into sugar by hydrolysis. Kirchhoff discovered the amylase enzyme between 1800 and 1815. Enzymes are being utilised in diverse reactions due to their





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biodegradability and ability to be manufactured from biological sources. Can be generated using Solid-State Fermentation (SSF) and Submerged Fermentation (SmF). The amylase enzyme was purified using ammonium precipitation and subsequent dialysis. It is utilised in a variety of applications such as bread manufacturing, textiles, paper, and the detergent sector.

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Table 1: Microbial Source: (Far, et al, 2020)

FUNGAL SOURCE	BACTERIAL SOURCE
Pycnoporussanguineus	Rhodothermus marinus
Penicillium janthinellum	Halomonasmeridiana
Penicillium chrysogenumm	Halobacillus sp.
Engyodontium album	Chromohalobacter sp.
Penicillium roquefortii	Bacillus coagulans
Aspergillus niger	Bacillus amyloliquefaciens
Thermomyceslanuginosus	Bacillus cereus
Penicillium fellutanum	Bacillus licheniformis
Aspergillus oryzae	Bacillus subtillis

Table 2: Produce by various microorganisms: (Ahmad, et al, 2019).

MICROORGANISMS	PH	TEMPERATURE
Aspurgillus niger	5.5	30℃
Aspergillus fumigatus	6.0	30℃
Bacillus amyloliquefaciens	7.0	33℃
Bacillus sp.	4.5	70°C
Bacillus subtilis	7.0	37℃
Mucor sp.	5.0	60℃
Malus pumila	6.8	37℃
Penicillium fellutanum	6.5	30℃
Penicillium olsonii	5.6	30℃





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Table 3: Condition for fermentation process in various microorganism: (Tiwari, et al, 2015).

NAME OF MICROORGANISM BACTERIA	TYPE OF FERMENTATION	PH	TEMPERATURE
Bacillus amyloliquefaciens	SMF	7.0	33℃
Bacillus sp. PS-7	SSF	6.5	60℃
Bacillus sp. KR-8104	NA	4.0-6.0	70-75°C
Bacillus subtilis KCC-103	SMF	6.5	37℃
Bacillus subtilis DM-03	SSF	6.0-10.0	50℃
Bacillus subtilis JS-2004	SMF	7.0	135℃
FUNGI			
Aspergillus niger ATCC	SMF	5.0-6.0	30℃
Aspergillus niger UO-1	SMF	4.95	50℃
Aspergillus oryzae	SSF	7.0	35℃
Thermomyces lanuginosus	SSF	6.0	50℃
Thermomyces lanuginosus	SSF	6.0	50℃





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RESEARCH ARTICLE

An Ecocritical Study of Human-Nature Dualism in Anuradha Roy's An Atlas of Impossible Longing

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ABSTRACT

Ecocriticism, as a literary and cultural theory, emerged during the late 1980s and early 1990s to study the relationship between literature and ecology from an interdisciplinary perspective. It offers various ecological insights to evoke environmental consciousness among the readers and examines the treatment of nature in literature. This paper attempts to explore human attitude towards the nature and nature's reaction to human intervention in Anuradha Roy's An Atlas of Impossible Longing. Anuradha Roy, an Indian novelist, has made significant contributions to contemporary Indian literature. This paper examines the human engagement with the non-human world with the intention to foster a harmonious relationship but ends up establishing dominance over it, thus leading to the exploitation of the nonhuman world. It reiterates how nature reclaims its own space as an act of retaliation against human encroachment and also the complexity involved in human-nature relationship. These aspects are elucidated through various instances from the novel.

Keywords: Ecocriticism, literature, ecology, harmonious relationship, dominance and human-nature relationship.





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INTRODUCTION

Ecocriticism, as put forth by Cheryll Glotfelty in The Ecocritical Reader: Landmarks in Literary Ecology, is "the study of the relationship between literature and the physical environment" (xviii). As a literary and cultural theory, emerged during the late 1980s and early 1990s, Ecocriticism deals with study of relationship between the human and nonhuman worlds in literature. Pramod K Nayar in his Contemporary Literary and Cultural Theory: From Structuralism to Ecocriticism states that Ecocriticism seeks to explore every period's attitude to non-human life and the portrayal of relationship between the human and the non-human in literary texts (Nayar 243). According to Lawrence Buell, Ecocriticism is the study of relationship between literature and environment with a dedication in applying environmentalist principles to protect nature (430). Garrard believes that ecocriticism has the ability to define, examine, and resolve ecological issues which makes it stand out among other literary and cultural theories. (6) As an interdisciplinary field, Ecocriticism derived its insights from philosophy, feminism, Marxism, sociology, environmental studies, anthropology, and also from other disciplines working at the level of discourse and application. Ecocritics analyse literary texts from an ecocentric perspective with a special focus on the representation of the natural world and emphasize the need for a symbiotic relationship between human and non-human worlds. Anuradha Royhas made significant contributions to the contemporary Indian literature. She has written five novels that are translated into many different languages and won various literary awards. It was shortlisted for the "Crossword Prize" in India and long listed for the "IMPAC Dublin Award 2008." Her second novel, The Folded Earth (2011), was shortlisted for the "Hindu Literary Award" and long listed for the "Man Asian Literary Prize" in 2011. Her third novel, Sleeping on Jupiter (2015), won the "2016 DSC Prize" for fiction and is shortlisted for several other prizes. Her fourth novel, All the Lives We Never Lived (2018), won the "Tata Book of the Year Award for Fiction 2018" and in December 2022, it won India's most prestigious literary prize, the "Sahitya Akademi Award."

The Earthspinner, her fifth novel published in 2021 won the "Sushila Devi Book Award 2022" for the best novel by a woman writer in India. It was shortlisted for the "Tata Book of the Year Award for Fiction 2022" as well as the "Rabindranath Tagore Literary Prize 2022." The present study is on her debut novel, An Atlas of Impossible Longing (2008). Her writings delve deep into various socio-political issues and the complexities of the contemporary Indian society. She has been celebrated for her evocative style of writing by weaving together different narrative techniques. Her descriptions of landscapes and natural world reflect her observant nature as she details the flora and fauna of the particular area. Her characters are well-crafted to bring out the intricacies of the Indian socio-political context as they are drawn from different social strata addressing issues pertaining to gender dynamics, displacement, socio-political unrest, loss, longingness, cross-cultural differences, class distinction, isolation, identity crisis, and environmental problems. An Atlas of Impossible Longing is a multigenerational tale set in different places in India. It has been widely translated and was named one of the best books of the year by "The Washington Post" and "The Seattle Times." The novel has been divided into three sections titled "The Drowned House," "The Ruined Fort," "The Water's Edge." It weaves the stories of Amulya Babu, who moves with his family from Calcutta to a small town called Songarh in the outskirts of Bengal and starts a business on herbal medicines and perfumes while his wife Kananbala, the matriarch goes slowly mad because of loneliness. Nirmal, an archaeologist, the younger son of Amulya, is caught up with his feelings for an unmarried cousin, Meera. Bakul, his motherless daughter, struggles a lot, longing for love and affection, runs wild with Mukunda, an orphan adopted by the family. The novel explores themes of love, loss, longingness, identity crisis, rural versus urban life, gender and class distinctions. Initially, humans seek to engage with the natural world with the intention of fostering a harmonious relationship. Over a period, their actions establish dominance over the natural world as they believe that human beings are the primary or central entities of the universe and the existence of other living and non-living beings are based on their instrumental value to serve human needs. In Grey's words, "Our perspectives, values and judgements are necessarily human perspectives, values and judgements. Within the moral world we do occupy a privileged position" (464). Human tendency to perceive the natural world in terms of its instrumental value leads to an exploitative attitude that causes serious threat to the environment. On the contrary, most of the time, it is the nature that acts as a nurturer, provider, and





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refuge to the human world. When human intervention exceeds, the natural world explodes to reclaim its own space as an act of retaliation against human encroachment.

MATERIALS AND METHODS

An Atlas of Impossible Longing(AIL) by Anuradha Roy serves as the primary source for this paper. A qualitative analysis of the text from an ecocritcal perspective is carried out to understand the dynamic relationship between human and non-human worlds. An ecocritical approach looks at the representation of nature and landscape in cultural texts, paying attention to human attitudes towards the natural world.

RESULTS AND DISCUSSIONS

Celebrating nature through harvest festivals indicates the human's effort to maintain harmony with nature. Harvest festivals are celebrated as a means of thanksgiving and acknowledging nature for its role in providing sustenance. Such practices enhance the harmony between human and nature, and recognizing nature's inevitableness in human lives. In AIL, the tribals celebrate the harvest festival with great enthusiasm with firelights, cooking traditional foods, drums, and twanging of instruments. The celebration is "Beyond the pool of firelight, cooking smells, and noise, the forest darkened into shadows. Somewhere, a buffalo let out a mournful, strangled bellow"(6). Men and women dance by singing songs and greet visitors and guests. The reverence towards nature emphasizes the need for a harmonious relationship between human beings and the natural world. As a result, such attitudes are seen predominantly among the local and indigenous community as they are in close association with the natural world. Such human activity towards the natural world expresses the reverence towards the natural world. Nature acts as an emotional refuge and comforter to suffering individuals with its serenity and healing property and for the physical and mental well-being of human beings. It serves as a way to escape from the everyday mundane lifestyle. The tranquility of the landscapes, unaffected by much human intervention paves way for self-contemplation. For instance, Meera comes to the ruin almost every day to feed the weak dog and its puppies. After the household chores, she comes with some food to feed them though she knows they would survive with or without her. She moves away from the house not only to feed the dogs but also to have a time for her with nature than to be confined in a small space. Roy portrays,

Limping behind her was an emaciated dog, brown and black, fur eaten away in patches, swollen dugs hanging to the ground. It pushed its eager muzzle into Meera's hand, whining. Meera still had the fragment of a roti in her hand ... Meera said, "I like to walk – otherwise I feel cooped up – and also, I sometimes sit here and draw. It's a break from housework." (112)

Similarly, Bakul and Mukunda, had their own secret places in the wilderness. Both of them shared different distress; Mukunda faced caste discrimination because of his unknown parentage, Bakul had no one to care for her as her archaeologist father is far away. Both considered themselves to be orphans and their only way to let out their anguish is nature. They spent their time in secret places and in their garden with tall trees and grasses. They considered their time spent in nature is restorative amidst the trees, birds, and flowers.

Mukunda had not heard her. He pointed to a mango tree in the centre of the garden. It stood innocuous in the afternoon sun, sheltering a family of birds that flew in and out of it, chiding each other as he approached. "That's the pyramid," he said, excited, "All around there is just sand ... the two of them wandered their garden of old trees and tall grass. Tangles of wildflowers nodded under the weight of pausing butterflies. (102)

Nature does wonders in the physical and mental well-being of human beings. Nature plays a crucial role in the lives of Meera, Bakul, and Mukunda. Their comfort is found in nature when they are distressed. The natural setting often rejuvenates the mental health of the characters which in turn has an impact on their physical well-being.





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Human attitude towards nature changes from time to time and they may appear to be ecocentric, but the lingering anthropocentric ideology makes them view nature as a resource for exploitation. Amulya's eagerness towards nature forced him to move from Calcutta to Songarh, a rocky ruined place in the outskirts of West Bengal. In the initial stage, it appears as though he moved towards nature to live in harmony with it, but the actual reason is based on the utilitarian views towards the land and indigenous people in order to expand his ambitious ideas. He considered Songarh to be a place away from much human interruption, would be the right choice to set up his small factory to manufacture perfumes and medicines from the rich flora of the forest. He also made use of the knowledge of the local people to trace various plants, flowers, and herbs to be used for his products. The knowledge of the indigenous community about the flora of the area is portrayed as

The people of the forest knew where to find wild hibiscus flowers for fragrant and red oil, flowers of the night for perfumes, and the minute herbs for smelly green pastes that could bring stubborn, hard boils to tender explosion overnight...learned enough from them of their plants to be able to expand the range of his products. (12)

Human intention to occupy the uninhabited land is not to live in harmony with it but to exploit and utilize the available resources of the region for their benefit. Through their action they establish their dominance over nature. Human desire for resources is the major cause of environmental depletion and exploitation of natural resources. With the discovery of mica ores in Songarh, the natural elements seem to be disturbed. A tiny colony of people who supervised the coal mines formed a compact society amidst the patchy fields of millet and greens. The wandering of leopards, jackals, and tigers were also reduced due to human intervention in the area. "Until the mines came, and with them the safety of numbers, nobody from the town was foolhardy enough to venture into the wilderness at the edge of their homes: green, dark, alien, stretching for miles, ending only where the coal mines began" (12). The local community did not make any effort to get into the wilderness except to satisfy their vital needs before the intervention of the mining process; hence the area remained undisturbed with its greenery stretching for miles. The intervention of the mining operation altered the town's relationship between the indigenous community and the surrounding wilderness. Mining operation has its impact on the landscape and ecosystem, and such activities transformed the wilderness to a place of exploitation altering the natural world. Exploitation of nature over a period of time will result in the outburst of nature. It makes nature unpredictable to the human knowledge and experience. When nature expresses its rage, it is always beyond human comprehension. For instance, the heavy continuous rain in Manoharpur each year was different. Bikash Babu built his house on the banks of the river and trusted the strong walls of his house against the power of nature. He also felt that it was something common they face every monsoon, which would last for a week or two, then the water level will decrease and they will get back to normal. He says, "Every monsoon we go through this nonsense. As did my father and grandfather. In a week or two the rain will lessen and then the water will go down. Just a few dry days in between the rains will be enough" (71). Although the situation seemed to be normal, it became worse when the river broke its banks and flooded completely. The house has been drowned with powerful roar and drumming of rain. The haughtiness of nature invited an unexpected disaster in Manoharpur that caused the life of poor Shanti while delivering her baby. Bikas Babu understands the reality very late that it is beyond his control, "The river will drown the house today, it's broken its banks, it's finding a new path," he said in a murmur. She could hardly hear him over the drumming of the rain. "Can you hear its roar? Can you feel its power?" (73-4). The unrestrained power of the river represents the potential human impact on the environment that triggers nature to be an active force. This depicts the dynamic relationship between human beings and natural world.

CONCLUSION

Human exploitation of the natural resources is the primary cause for environmental crisis. Roy portrays various aspects to human-nature relationship in this novel, *An Atlas of Impossible Longing*. She works on various grounds to distinguish the human attitude towards nature and vice versa. Human beings' gradual move towards nature ends up





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with an exploitative attitude. On the other hand, nature serves as nurturer, supplier, and a refuge but explodes with an intolerance to human exploitation in the due course. In order to maintain a symbiotic relationship, there must be a change in human attitude towards the treatment of the natural world.

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RESEARCH ARTICLE

Effects of MHD and Viscous Heat Generation in Esterification

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ABSTRACT

In an equilibrium reaction for a vertically oscillating semi-infinite plate, the heat transfers and mass transfer induced by the simultaneous action of buoyancy, viscous dissipation, and the oblique magnetic field are investigated. Similarity transformations are applied to the nonlinear fluid flow to convert ordinary differential equations from the partial differential equations, and the result is determined using bvp4c. The concentration profile is shown graphically. The effects of various phase angles, (Grt and Grm) the Grashof number, (M) the magnetising field parameter, (E_c) the Eckert number, and (K_{eq}) equilibrium constants are discussed. It is noticed that the steady state reaches faster in a reversible reaction than in an irreversible reaction, and in both cases, the rate of mass transfer is higher for ωt and M.

Keywords: Esterification, heat flux, mass flux, Magnetohydrodynamics.

INTRODUCTION

Esterification and its application:

Esterification, the well-known equilibrium reaction to form ester using carboxylic acid and alcohol with an acid catalyst, is one of the most practiced technologies in the chemical industry. Esterification is a crucial process in chemical synthesis. Esters can be found in a variety of chemical substances, both natural and man-made. In organic chemistry, esterification is referred to as a condensation reaction. Routine production of esters by manufacturers focuses on parameters such as heat flow, fluid flow, viscosity, etc. Application of an esterification process is found in industries such as solvents for paints, lacquers, and varnishes; pharmaceuticals; adhesives; bio-plastics and coatings;





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flavours and cosmetics; herbicides and pesticides and emulsifiers; perfumery; food; and producing bio-diesel from lower-quality feedstock [1].

REVIEW OF THE LITERATURE ON CHEMICAL REACTION, VISCOUS DISSIPATION, AND MHD:

In the vicinity of an infinite isothermal vertical plate, Imran et al. [2] explored an incompressible, homogeneous Newtonian fluid. For solving flow equations, the Laplace transform method and the homotopy perturbation method were used. In the velocity field, the effect of the Ekman number was found to decrease the thickness of the moving fluid layer under faster frame rotation. Subhrajit Sarma et al. [3] worked on an exponentially enhanced semi-infinite perpendicular plate in the medium with porous material under the impact of MHD and observed that both the Dufour effect and an arbitrary ramped temperature reduce fluid velocity. In their study of unsteady MHD slip flow across a permeable vertical plate using an inclined magnetic field, Oyekunle et al. [4] discovered that both Dufour and Soret have a propensity to enhance velocity profiles. Sheikholeslami et al. [5] examined the effects of thermal dissemination and heat propagation on MHD nanofluid flow via a vertically oscillating plate using the Laplace transform. They concluded that while the temperature drops with an upsurge in Prandtl number Pr, it accelerates with a rise in volume fraction criterion, heat propagation parameter, and time t. Anil Kumar and colleagues [6] investigated how thermal radiation affected MHD heat transport and spontaneously initiated vertical plate flow using the finite element approach. They found that raising the radiation parameter value enhanced the fluid rate profile and temperature profile. A study by Md. Hasanuzzaman et al. [7] looked at how viscous dissipation and thermal emission affect the movement of heat mass in an unstable magneto-convective system on a vertical porous plate. They found that fluid temperature and velocity rose with increasing Eckert number values. The force of wall conduction and viscous dissipation were examined on steady mixed convection by A.O. Ajibade et al. [8], who considered the couette flow of a heat-generating or heat-absorbing fluid, and it was found that the heat transfer rate reduces the thickness of the boundary plate (d) while the critical value of (Gre) surges up. As a consequence, the study proved that boundary plate thickness is important for mixed convection research. Dadheech et al. [9] investigated entropy exploration for radiative inclined MHD slip flow with a heat source in porous media for two dissimilar fluids using the Runge-Kutta method of order four with a shot approach. It appears that increasing the magnetic field parameter, porosity parameter, and magnetic field inclination angle increases entropy generation, whereas decreasing the slip parameter has the opposite effect for both fluids. Md. Hasanuzzaman et al. [10] numerically investigated the emission of thermal on unsteady magneto-convective heat and mass transport, and the results show that increasing the Soret and Dufour numbers lessens the thermal delimiting layer width.

Reddy et al. [11] looked at the collective effects of heat sources, radiation, and viscous dissipation on MHD flow through an exponentially stretched sheet with the impact of Soret and Dufour. According to the study, the magnetic field slows down the fluid rate. Temperature and fluid concentration decrease as the Dufour number rises. Krishna M.V. and colleagues [12] investigated the impact of Hall and ion slip on the MHD rotational flow of an elasticoviscous fluid in a porous medium. They discovered that the boundary layer is getting thinner as elasticity and the magnetic field oppose fluid rates. The reverse flow is alarmed by a lower frequency of fluctuating pressure gradients. M. Veera Krishna et al. [13] studied the Hall effects on nanofluid between two parallel discs. The temperature and concentration of nanoparticles increased significantly due to Brownian motion and thermophoresis processes. The temperature and concentration disseminations for absorption and blowing together rise evenly when the suction or blowing parameter rises. A study by Krishna M.V. et al. [14] on unsteady MHD convective rotating flow through an infinite vertical moving permeable surface found that the concentration profiles get higher as the suction parameter goes up. Schmidt number and slip parameter strengthening have an impact on the rate of mass transport. The Nusselt number rises with higher magnetic parameter values, according to Solomon Bati Kejela et al.'s [15] exploration of the effects of thermal radiation, magnetic field, Eckert number, and thermal slip on MHD Hiemenz flow. Additionally, it was perceived that the fluid rate rises as the Eckert number, the blowing/absorption criterion, and the permeability parameter rise, but that it falls off when the magnetic field and the velocity slip parameter grow. Solomon et al. [16]; studied analytically the buoyancy effects, internal heat production, magnetic





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field, and thermal emission on a boundary layer over a vertical plate with a convective surface boundary condition. They concluded that as the Biot number rises, so do the fluid velocity, temperature profile, and skin friction coefficient. It was also detected that as the magnetic parameter increased, both fluid velocity and temperature profiles decreased. Piyu Li et al. [17] reported on the thermal aspect of the Jeffrey nanofluid in a curved geometry channel with applications of Hall effects. Additionally, included are heat radiation and viscous dissipation. The MATHEMATICA programme was used to carry out the numerical shooting method. They came to the conclusion that an increased variation in the Hall parameter causes the velocity magnitude to decrease in the superior part of the channel while boundary layer phenomena emerge in the base half. The curvature parameter shows a declining tendency in the temperature profile. Yikai Li et al. [18] explored experimentally the collaboration between the droplets and vibrating engine body and the dynamic performances of droplets impacting on a vertically vibrating plate.

Originality of the projected problem

In the above references, these collaborative research projects greatly enhance our understanding of the complex interactions between fluid dynamics, energy transfer, mass transfer, and chemical reactions in various physical and technological settings. Previous studies have provided useful insights on fluid dynamics but have not addressed the reversible reaction over a vertically oscillating plate with varying criterions. By identifying this, the author has given a new dimension to reversible reactions. The effect of MHD and viscous dissipation, along with uniform heat flux and mass flux in the boundary, is analysed over an oscillating vertical plate in an esterification process. The governing partial differential equations converted into simpler ordinary differential equations (ODEs) in order to tackle this complex problem. The bvp4c solver, a reliable MATLAB built-in software tool, is then used to solve these nonlinear ODEs. The reversible reaction of ethanolic acid and methanol is looked at, along with the corresponding equilibrium constant. The concentration for different parameters of both reversible and irreversible reactions are then compared. This work has the potential to enhance practical applications in engineering, environmental science, and industrial processes.

MATHEMATICAL BACKGROUND

The unsteady, incompressible, two-dimensional viscous flow with MHD and viscous dissipation over a semi-infinite vertical oscillating plate is considered. The fluid surrounding the plate is a combination of carboxylic acid and alcohol with sulphuric acid as a catalyst. Carboxylic acid requires heat to react with alcohol to form an ester. The plate is placed upward in the axial direction. The magnetic field \mathcal{B}_0 and abscissa are perpendicular to the plate. Initially, at t less than zero the velocity along with the plate is taken to be u=0. The wall as well as the fluid are considered to be at consistent temperature \mathcal{T}_∞ and concentration $C_*\infty$. When time exceeds zero, the plate is set to

oscillate between abscissa and ordinate with the velocity $U(x,t') = \cos\omega t'$.

The mathematical form of the law of mass conservation:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \tag{1}$$

The equation of motion along x direction:

$$\frac{\partial u}{\partial t} + \frac{\partial u}{\partial x}u + \frac{\partial u}{\partial y}v - \frac{\mu}{\rho}\frac{\partial^2 u}{\partial y^2} = g\beta_1(T - T_{\infty}) + g\beta_2(C_* - C_*\infty) - u\frac{\sigma B_0^2}{\rho}$$
(2)

The term $+geta_1(T-T_\infty)$ specifies the up flow of the fluid.

The equation of thermal boundary layer:

$$\frac{\partial T}{\partial t} + \frac{\partial T}{\partial x}u + \frac{\partial T}{\partial y}v - \frac{\kappa}{\rho C_p} \frac{\partial^2 T}{\partial y^2} = \left(\frac{\partial u}{\partial y}\right)^2 \frac{\mu}{\rho C_p}$$
(3)





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The term $\left(\frac{\partial u}{\partial y}\right)^2 \frac{\mu}{\rho C_p}$ represents heat due to friction

Species concentration equation

Given that the solute exists in two forms throughout the esterification process: (i) A diffusible, unrestricted solute

(ii) A solute that has undergone a reaction is fixed at the site.

If the process is more rapid and reversible than diffusion, then $C_{**} = K_{eq}C_{*}$, where C_{**} is the concentration of the

solute that has previously reacted, C_* is the concentration of the unreacted solute that can disseminate and K_{eq} is the equilibrium constant of the reaction.

In general, the mass balance is (ADy) accumulation = (diffusion in minus out) + (amount created by reaction in ADy). The diffusing solute mass balance is

$$\frac{\partial C_*}{\partial t} + u \frac{\partial C_*}{\partial x} + v \frac{\partial C_*}{\partial y} = D \frac{\partial^2 C_*}{\partial y^2} + r_1 \tag{4}$$

 r_1 = chemical reaction effect.

Similarly mass balance for second species is

$$\frac{\partial C_{**}}{\partial t'} + \frac{\partial C_{**}}{\partial x}u + \frac{\partial C_{**}}{\partial y}v = -r_1 \tag{5}$$

Since the reacted solute cannot disperse, the diffusion term is not present. Moreover, the reaction term has a negative sign but the same size because any solute that vanishes as species 1 repeats as species 2.

The reaction term is eliminated by adding Eqs. (4 and 5) to get Eq. (6)

$$\frac{\partial (C_* + C_{**})}{\partial t} + \frac{\partial (C_* + C_{**})}{\partial x} u + \frac{\partial (C_* + C_{**})}{\partial y} v = \frac{\partial^2 C_*}{\partial y^2} D \tag{6}$$

The equilibrium reaction occurs by replacing $C_{**} = K_{eq} C_*$ in Eq.(6)

$$\frac{\partial C_*}{\partial t} + \frac{\partial C_*}{\partial x} u + \frac{\partial C_*}{\partial y} v = \frac{\partial^2 C_*}{\partial y^2} \frac{D}{1 + K_{eq}}$$
(7)

Here Keq refers equilibrium constant.

$$K_{eq} = \frac{[ester][water]}{[alcohol][acid]}$$

Considering a semi-infinite vertical hot flat plate carrying out harmonic oscillations in its own plane, the following initial and boundary conditions are framed:

$$t' \leq 0: u = v = 0, \quad T_{\infty} = T, C_{*\infty} = C_{*}$$

$$u = U \cos \omega t', \quad v = 0$$

$$t' > 0: \frac{\partial T}{\partial y} = -\frac{q''}{\kappa}, \quad \frac{\partial C_{*}}{\partial y} = -\frac{j''}{D}$$

$$u = 0, T_{\infty} = T, \quad C_{*\infty} = C_{*}, \quad at \quad x = 0$$

$$u \rightarrow 0, \quad T \rightarrow T_{\infty}, \quad C_{*} \rightarrow C_{*\infty} \quad as \quad y \rightarrow \infty$$

$$(8)$$





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Non-dimensionalization

We primarily employed the similarity transformation technique to transfer the governing PDEs (1), (3), and (7) into a system of nonlinearly coupled ODEs.

The subsequent stream functions $\psi(x, y)$ are introduced,

$$u = \frac{\partial \psi}{\partial y}$$
 and $v = -\frac{\partial \psi}{\partial x}$ (9)

which convinces the continuity Eq. [1].

Dimensionless quantities

$$\delta(t) = \sqrt{vt}, \eta = \frac{vx}{\delta}, \psi = \frac{vx}{\delta} f(\eta), u = \frac{vx}{\delta^2} f'(\eta), v = -\frac{v}{\delta} f(\eta), \omega' = \frac{v\omega}{U_0^2},$$

$$t' = \frac{tU_0^2}{v}, U = \frac{vx}{\delta^2}, \theta(\eta) = \frac{T - T_{\infty}}{T_w - T_{\infty}} \frac{U_0}{U}, \phi(\eta) = \frac{C_* - C_{*_{\infty}}}{C_{*_w} - C_{*_{\infty}}} \frac{U_0}{U}$$

$$(10)$$

Here U_0 and U are the mean fluid velocity and the uniform fluid velocity respectively, ν = fluid's kinematic viscosity, t and ω are dimensionless time and frequency, δ is a time-dependent length scale and η is considered to be stretching factor.

Governing equations in ordinary differential form

$$f'''(\eta) = -\left[f(\eta) + \frac{\eta}{2}\right]f''(\eta) - \left[1 - f'(\eta) - M\right]f'(\eta) - Gr_{t}\theta(\eta) - Gr_{m}\phi(\eta)$$

$$\tag{11}$$

$$\theta''(\eta) = \Pr\left\{-\left[f(\eta) + \frac{\eta}{2}\right]\theta'(\eta) + \left[f'(\eta) - 1\right]\theta(\eta) - Ec\left[f''(\eta)\right]^{2}\right\}$$
(12)

$$\phi''(\eta) = Sc\left(K_{eq} + 1\right) \left\{ -\left[f(\eta) + \frac{\eta}{2}\right] \phi'(\eta) - \left[1 - f'(\eta)\right] \phi(\eta) \right\}$$
(13)

Dimensionless boundary conditions

$$t \le 0: f'(0) = f(0) = \theta(0) = \phi(0) = 0$$

$$t > 0$$
: at $y = 0$, $\eta = 0$

$$f'(0) = \cos \omega t, \quad \theta'(0) = -1, \quad \phi'(0) = -1$$
 (14)

where
$$M=\frac{\sigma B_0^2 \delta^2}{\rho v}$$
 is magnetic parameter, $Gr_t=g\beta_1\Big(T_w-T_\infty\Big)\frac{\delta^2}{v\,U_0}$ is a thermal Grashof number ,

$$Gr_m = g\beta_2 (C_{*w} - C_{*\infty}) \frac{\delta^2}{vU_0}$$
 is a mass Grashof number, $Ec = \frac{UU_0}{C_D \Delta T}$ is a Eckert number, $Sc = \frac{v}{D}$ is a

schmidt number and $Pr = \frac{v}{\alpha}$ is a Prandtl number.





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CHEMICAL BACKGROUND

Equilibrium Reactions

The below reactions refer esterification process by combining ethanoic acid with four types of alcohols under the influence of H_2SO_4 as catalyst [Edward Sarlo et al. [19]].

$$\begin{split} &CH_3OH + CH_3CO_2H \underset{K_{eq} = 5.03}{\longleftrightarrow} CH_3COOCH_3 + H_2O \\ &C_2H_5OH + CH_3CO_2H \underset{K_{eq} = 4.86}{\longleftrightarrow} CH_3CO_2C_2H_5 + H_2O \\ &C_3H_7OH + CH_3CO_2H \underset{K_{eq} = 4.21}{\longleftrightarrow} CH_3CO_2C_3H_7 + H_2O \end{split}$$
 RESULTS AND DISCUSSIONS
$$C_4H_9OH + CH_3CO_2H \underset{K_{eq} = 2.85}{\longleftrightarrow} CH_3CO_2C_4H_9 + H_2O \end{split}$$

The $_{bvp4c}$ is implemented for solving the non-linear ODE (11) - (13) with boundary conditions (14). In this technique, the outcomes are achieved by fixing various initial values for f''(0), $\theta(0)$ and $\phi(0)$. Here, the graphical representation is made for both reversible and irreversible reactions. The equilibrium constant for a reversible reaction of methanol and ethanolic acid with the acid catalyst sulphuric acid to get methyl propionate and water is 5.03. The Prandtl number and Schmidt number are taken to be 2.69 at 337.7 K and 0.97, respectively. For an irreversible reaction, the Schmidt number is 0.6.

Steady state Concentration Profiles

By changing the concentration of the reactants or products in a reaction at equilibrium, the proportions of reactants and products adjust themselves in such a way that they do not change, provided the temperature does not change. In general, figures 2 to 6 indicate that the steady state is quickly achieved in a reversible reaction and that the species boundary layer thickness is higher for an irreversible reaction. In figure 2, the increase in the phase angle increases the concentration for a reversible reaction, and it is noticed that at low concentration and during the oscillation, the profile does not show any significant difference between the boundary layers. But for an irreversible reaction, the fluctuation occurs between the boundary layers. In figure 3, the increase in mass Grash of number depletes the concentration in both cases, and it is also found that boundary layers coincide for a reversible reaction. There is a tendency for the Grashof number to increase the mass buoyancy effect. Because of this, there is a noticeable rise in the induced flow, which ultimately leads to a reduction in concentration. As a result of the presence of a high concentration gradient, the irreversible reaction illustrates that the mass buoyancy effect is most pronounced in the vicinity of the wall. In figure 4, by enhancing the magnetic parameter, the concentration level increases in both reactions. Because of the temperature gradient that is intrinsic to the fluid's viscosity, the concentration profile of the fluid grows exponentially with the magnetic parameter.

Due to the fact that an increase in the magnetic parameter causes a reduction in the size of velocity profiles in the boundary layer, it is clear that the magnitude of concentration profiles increases as the magnetic parameter increases. Therefore, the decrease in velocity that takes place within the border layer during the process is what causes the diffusion of mass in the boundary layer. It has been discovered that magnetic field therapy for plants and animals is a useful and developing technique for disease prevention and boosting resistance to unfavourable environmental conditions. In **figure 5**, the elevation of the Eckert number depletes the concentration in both reactions. The fluid's enthalpy and kinetic energy are defined by the Eckert number. It is employed to denote the significance of a fluid's self-heating as a result of dissipation effects. Internal friction leads a decrease in concentration. In **figure 6**, the concentration boundary layer thickness is too large for an irreversible reaction when compared with reversible reactions, and the fluctuation in concentration is also found in reversible reaction. The following outcomes are





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obtained from an effect of MHD and viscous dissipation over a semi-infinite oscillating vertical plate with consistent heat and mass flux in the boundary under an equilibrium reaction.

- The steady-state for concentration profiles is attained faster for a reversible reaction.
- While increasing phase angles, the concentration fluctuates for an irreversible reaction.
- Since the reaction rate in a reversible reaction is faster than the diffusion rate, the boundary layer thickness is less than in an irreversible reaction.
- In both cases, the magnitude of skin friction increases with higher values of Ec.
- In both cases, concentration near the wall is greater for M.
- The concept of heat and mass transfer in esterification is applied in the painting industry. This work can be carried out using nano and hybrid nanoparticles in equilibrium reactions.

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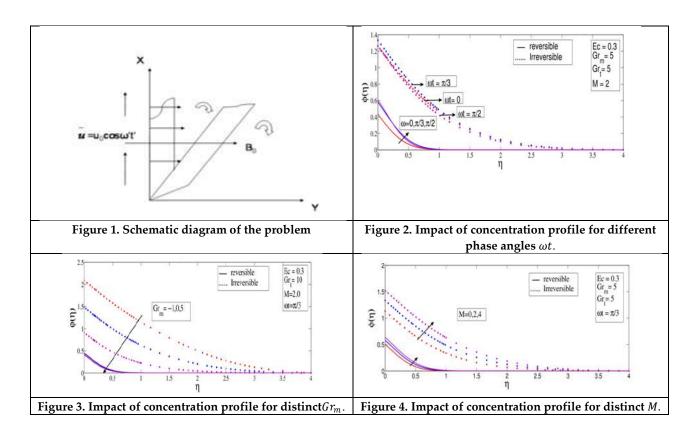
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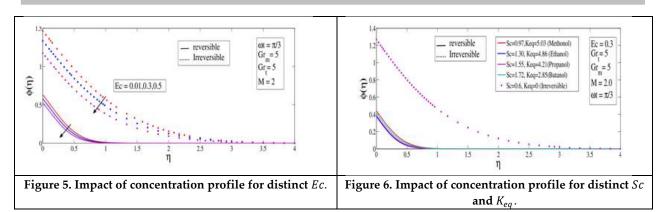
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RESEARCH ARTICLE

Anti-Inflammatory Activity and Analgesic Activity of Traditional Herbo-Mineral Preparation Saara Lavana Parpam (SLP)

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ABSTRACT

In chronic diseases such as diabetes, arthritis, cardiovascular disease, cancer, and others, pain and inflammation are related occurrences. Long-term usage of corticosteroids and non-steroidal antiinflammatory medicines may result in adverse effects. The purpose of this study was to examine Sara lavana Parpam's analgesic and anti-inflammatory properties in experimental animal models. extracts of Sara lavana Parpam's were subjected for anti-inflammatory and analgesic screening. Carrageenan and Eddy's hot plate method were used to assess anti-inflammatory and analgesic effects, respectively. Saara Lavana Parpam were found to be significant (p<0.05) effective in reduction of paw volumer after 3 hrs. The dose of 12mg/kg/p.o showed significant analgesic (p<0.05) activity. In summary, All the extracts of Sara lavana Parpam's possess significant anti-inflammatory actions. This study adds evidence on the traditional use of Sara layana Parpam for treating painful inflammatory disorders.

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Keywords: Carrageenan and Eddy's hot plate method were used to assess anti-inflammatory and analgesic effects, respectively.

INTRODUCTION

Background

Inflammation is a defense response to harmful stimuli, such as allergens and tissue injury, which can lead to various disorders such as allergies, cardiovascular dysfunctions, metabolic syndrome, cancer, and autoimmune diseases. Uncontrolled inflammatory responses can cause a wide range of disorders, imposing a significant economic burden on individuals and society.¹Common medications for controlling and suppressing inflammatory crises include steroids, nonsteroid anti-inflammatory drugs, and immune suppressants, which are often associated with adverse effects.²In order to achieve the highest efficacy and minimal adverse effects, natural anti-inflammatory factors should be used in medication therapy. Herbal medicines are promoting subjects in medicine, with complementary, alternative, and traditional medicines serving as the primary source of herbal medication guidance. However, modern medicine must prove these guidelines through scientific methods before using them in practice²-³.

According to the World Health Organization, approximately 80% of the world population still use plant-based drugs which include the medicinal use of plants as anti-nociceptive drugs in traditional treatment. This review aims to assess the clinical evidence of plants and their anti-inflammatory effects, focusing on the importance of natural anti-inflammatory factors in medication therapy. It is crucial to increase our knowledge about herbal medicines and their potential benefits in medicine.

METHODS AND MATERIALS

Preparation of SLP extract

The SLP were prepared as per classical text⁵ .The finished product was gathered and kept in a porcelain container that was airtight. The extract was suspended in honey and used as test drug sample for the animal studies.

Phyto chemical analysis

The extract was subjected to phyto chemical analysis for constituent identification using standard protocol

Anti Inflammatory Activity of SLP^{6,7}

Animals

Wister albino rats (150-200 g) of approximate same age were employed in this investigation. The animals were fed with standard pellet diet and water and ad libitum. They were housedunder standard conditions of temperature $22^{\circ}\text{C}(\pm 30^{\circ}\text{C})$ humidity 35 % to 60 %, and light(12:12 hr light/dark cycle) in poly propelyne cage. The animals received the drug treatments by oral gavages tube. All the experimental procedures were done following the guidelines of Institutional Animal Ethics Committee (IAEC). (IAEC approval No IAEC / XLIII / 10 / CLBM CP/ 2014)

Drugs and Chemicals

Aspirin, carrageenan, Freund's adjuvant were purchased from Sigma, Pentazocine was purchased from Ranbaxy Lab Ltd, New Delhi, India. All other chemicals were of analytical grade and procured locally.

Anti-inflammatory activity Carrageenan induced Paw Edema (Acute Model)

Acute inflammation was produced by injecting 1% solution of carrageenan in to plantar surface of rat hind paw at the dose of 0.1ml per 100g body weight (Winter et al., 1963). Wistar albino rats were divided in to four groups of six in each. A 2% solution of CMC at a dose of 0.1ml/100g/p.o was administered to group 1. The test drug sample was administered to the animals of group 2 and 3 at the dose range of 100, 200 mg/kg/p.o respectively against the standard drug Indomethacin at 5mg/kg/p.o to the 4. After 30 minutes carrageenan solution was injected to the





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animals of all the groups. The paw edema was measured at the intervals of 1, 2, 3 and 4h using Plethysmometer (Model-520-R,IITC Life science, USA). The paw edema among the different group of animals was compared, the percentage inhibition of paw edema was determined.

% inhibition of Paw Edema =100(1-Vt/Vc),

Vc-Paw edema of control animals

Vt-Paw edema of drug treated animals

Analgesic Activity of SLP

Animals

Healthy Mice of either sex weighing (20-25 gm) were used in this study. All the animals were obtained from King Institute. The animals were housed comfortably in a group of six in a single clean plastic cage with a metal frame lid on its top. They were housed under standard environmental conditions of temperature. All animals had free access to water and standard pelletized laboratory animal diet ad libitum. All the experimental procedures and protocols used in this study were reviewed and approved via the Approval No.(IAEC-Approved no XLIII/10/CLBMCP/2014)by the C.L. Baid Metha College of Pharmacy All the experimental procedures were done following the guidelines of Institutional Animal Ethics Committee (IAEC).(Approval No IAEC / XLIII / 10 / CLBM CP/ 2014)

Drugs and Chemicals

Diclofenac sodium adjuvant were purchased from locally .All other chemicals were of analytical grade and procured locally.

Analgesic Activity of SLP (Eddy's hot plate)

Using Eddy's hot plate, which was kept at $55 \pm 1^{\circ}$ C, the test was conducted. Every animal's baseline reaction time was noted. The research included the animals that responded with forepaw licking or leaping within 6 to 8 seconds. After the test and reference chemicals were administered, each animal in all three groups was given a 60-minute exposure to a hot plate that was kept at 55° C. Reaction time was measured as the number of seconds required for forepaw licking or leaping. To protect the paws, a 15-second cutoff time is followed. Analgesic efficaciousness was noted every two hours following the administration of the medication.

Eddy's hot plate technique: P<0.05 in comparison to the control group, N=6 results are reported as mean +_ S.D. USING ONE WAY ANOVA, then Dunnet's method

Statistical analysis

The values are represented by mean±SEM; Student's t-test was performed. P<0.05 was considered as significant.

RESULTS

The anti-inflammatory activity of test drug Saara Lavana Parpam was determined by Hind paw edema method. The results of anti-inflammatory activity by carageenan-induced paw edema methods showed in Table-1 . Saara Lavana Parpam were found to be significant (p<0.05) effective in reduction of paw volumer after 3 hrs. So above the reasons this study proved the test drug Saara Lavana Parpam (SLP) has anti-inflammatory activity. Eddy's Hot Plate Method was used to conduct an analgesic activity. Because it increases reaction time, the medication Saara Lavana Parpam(SLP) has strong analgesic effect (raise threshold potential of pain). In contrast, Saara Lavana Parpam(SLP) 200 mg/kg demonstrated a moderate level of activity in comparison to the control group. These findings clearly demonstrate Saara Lavana Parpam's(SLP) potent analgesic effects.

Analgesic activity of Saara Lavana Parpam(SLP) on Eddy's hot plate method





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DISCUSSION

The anti-inflammatory activity of test drug Saara Lavana Parpam was determined by Hind paw edema method. The results of anti-inflammatory activity by carageenan-induced paw edema methods showed a significant reduction in paw edema in the group treated with Saara Lavana Parpam compared to the control group. This suggests that the test drug has potential anti-inflammatory properties and could be further explored for its therapeutic benefits in inflammatory conditions. .Saara Lavana Parpam were found to be significant (p<0.05) effective in reduction of paw volumer after 3 hrs. The reduction in paw volume after 3 hours indicates that Saara Lavana Parpam acts quickly to alleviate inflammation. These findings support the potential use of this drug as a promising treatment option for inflammatory conditions. So above the reasons this study proved the test drug Saara Lavana Parpamhas antiinflammatory activity. In addition, the study also demonstrated that Saara Lavana Parpam exhibited a dosedependent response, with higher doses resulting in greater reduction in paw volume. This suggests that the drug's anti-inflammatory effects may be further enhanced with increased dosage. Overall, these findings provide strong evidence for the therapeutic potential of Saara Lavana Parpam in managing inflammatory conditions. Eddy's Hot Plate Method was used to conduct an analgesic activity. Because it increases reaction time, the medication Saara Lavana Parpam(SLP) has strong analgesic effect (raise threshold potential of pain). In contrast, Saara Lavana Parpam(SLP) 200 mg/kg demonstrated a moderate level of activity in comparison to the control group. These findings clearly demonstrate Saara Lavana Parpam's (SLP) potent analgesic effects. Furthermore, the dose-dependent nature of the analgesic effects suggests that careful dosage adjustment may be necessary to achieve optimal pain management without causing adverse side effects. Future studies could explore different dosage ranges to determine the ideal therapeutic range for Saara Lavana Parpam in managing pain in inflammatory conditions. In addition, the study also observed that the analgesic effect of Saara Lavana Parpam was dose-dependent, with higher dosages resulting in a greater increase in reaction time. This suggests that increasing the dosage of SLP may further enhance its analgesic properties, making it an effective option for managing pain in inflammatory conditions.

CONCLUSION

The study found that Saara Lavana Parpam has potential anti-inflammatory properties and could be used as a treatment option for inflammatory conditions. It was found to be effective in reducing paw volume after 3 hours, indicating its quick action in alleviating inflammation. The drug's analgesic effect was also strong, with higher dosages resulting in greater reduction in paw volume. The study suggests that careful dosage adjustment may be necessary for optimal pain management without adverse side effects. Future research could explore different dosage ranges to determine the ideal therapeutic range for Saara Lavana Parpam in managing pain in inflammatory conditions.

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Table 1 shows Anti-inflammatory activity of Saara Lavana Parpam

Group	Dose mg/kg	Mean Paw volume in ml				
0.10 .1 p		1hr	2hr	3hr	4hr	
Control	Vehicle	1.38 ± 0.064	1.42±0.005	1.48±0.009	1.50 ±0.003	
Indomethacin	10mg/kg	1.36 ±0.061*	1.30 ±0.034*	1.23 ±0.077**	1.05 ±0.060**	
Saara lavana parpam	100mg/kg	1.34 ±0.020	1.33 ±0.015*	1.25 ±0.066*	1.16 ±0.049*	
Saara lavana parpam	200mg/kg	1.31 ±0.043	1.30 ±0.010	1.22 ±0.078	1.07±0.061**	

Table 2: Analgesic activity of Saara Lavana Parpam(SLP) on Eddy's hot plate method

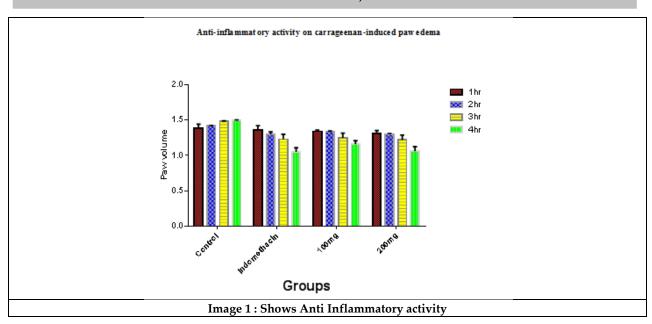
Dose	Paw licking response (see)			
	0 min	30 min	60 min	120 min
Control (Saline)	7.42±0.87	7.64±0.72	7.72±0.71	8.91±0.65
Diclofenac sodium	7.69±0.19ns	7.96±0.27	10.56±1.54	14.26±10.02
Saara Lavana Parpam	7.35±0.97 ns	7.90±1.19 ns	08.62±1.51	10.14±1.26





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RESEARCH ARTICLE

Removal of Lead and Cytotoxicity Studies of Synthesized Cerium Oxide Nanoparticles using Tea Waste Extract

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ABSTRACT

Modern science and technology have given rise to the word "nanobiotechnology." The goal of the current research was to create and characterize rare earth metal of cerium oxide nanoparticles from tea refuse extract, which were then tested for their ability to absorb lead and for their antibacterial and anticancer properties. By using a variety of analytical and instrumentation methods, including UV-Vis Spectroscopy the obtained cerium oxide nanoparticles were described. It was suggested and verified using a UV-Vis spectrometer; matching peaks at 343nm were found. By analyzing tea waste extract of CeO2 NPs, Furthermore, the human lung cancer cells exposed to the tea refuse extract of CeO2 Nanoparticles displayed dose-dependent cytotoxicity and apoptotic characteristics (A549 cell line). The overall conclusions pointed to the possibility of using tea waste extract to create rare earth metal cerium oxide nanoparticles as another biomaterial for potential use as an antibacterial and antitumor complex in the future. Additionally beneficial for lead absorption in hard water.

Keywords: Tea waste, cerium oxide nanoparticles, A549 cell lines, anticancer activity, Pb²⁺ absorption studies





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INTRODUCTION

A wide range of industries, including cosmetics and medicine, use nanoparticles (NPs). NPs are made up of macromolecular materials in which the active component (drug or physiologically active material) is dissolved, entrapped, encapsulated, or adsorbed. Their sizes range from 1 to 100 nm [1]. In the last ten years, a great deal of study has been done on metal nanoparticles. Physiological processes in biological structures are highly regulated and well-organized, which makes them a valuable tool in the production of nanoparticles. Concerns regarding the potential negative consequences of metal nanoparticles (NPs) persist, especially with regard to silver nanoparticles, which appear to be the most hazardous of all the metals.[2].Quantum dots (QDs) are being used in a variety of modern technologies that are aimed at advancing societal, industrial, and economic sectors as well as all other facets of life. The fabrication of quantum dots typically involves synthesizing and designing a nanotechnology system to enhance biological, sensing, and bioimaging performances [3]. Cerium oxide nanoparticles (CeO2 NPs) have many distinctive qualities and uses because they can be used as catalysts, solid oxide fuel cells, luminescent materials, and amperometry oxygen monitors [4]. CeO2 NPs have also primarily been used in medication delivery devices. Furthermore, these CeO2 NPs demonstrate the reality of the water treatment process. Environmental researchers find that removing Pb (II) from water and wastewater primarily through the use of chemical precipitation, ionic exchange, separation by membrane, the process of biosorption adsorption process, etc., presents a significant challenge in the global trend to reduce the allowable level of contaminants in drinking water [5]. Most of them, meanwhile, are expensive and require a lot of processing. As a result, developing more potent remediation methods that can remove Pb (II) from contaminated water at high concentrations is crucial. CeO2 NPs also exhibit promising biological functions, including antibacterial and anticancer properties, and applications in nanomedicine, the pharmaceutical sector, medical diagnostics, gene transport, and drug delivery. In China, one of the farming goods that is most popular in Asian nations is tea. To solve this problem, a number of methods for recovering tea waste have been created. Tea residue is most commonly used as an adsorbent to eliminate heavy metals and pigments from aqueous systems. The most efficient sequence is Pb (98%). Therefore, the goal of the current research was to synthesize and characterize cerium oxide nanoparticles (CeO2 NPs) using tea refuse extract for use as anticancer agents in human lung cancer cell lines, as well as to remove lead (Pb²⁺).

MATERIALS AND METHODS

Reagents

CTAB, dithizone propanol, lead nitrate, EDTA using xylene orange, HCL, cerium nitrate hexahydrate, methanol, conHNO₃, NH₄OH, potassium sodium tartrate, tetrahydrate. All additional chemicals, solvents, and reagents were purchased from genuine scientific equipment, Vellore (Tamilnadu). MTT and DMSO were purchased from Sigma in the United States (India). Tarson supplied the 96-well tissue culture dish and wash container (India).

Collection and preparation of the sample

In the Tirupattur district's Pillayarkovil Street, samples of hard water were gathered. The community receives an average of 877 millimeters of precipitation annually (34.5 in), with the driest months being September and October, which have 400 mm (16 in) and 16 in (16 in) of precipitation, respectively. 100g of unwanted tea waste was gathered from a seenu tea store in the Tamil Nādu region of India for second research.

Extraction of dry tea waste

The sample of tea garbage purchased from the Seenu tea shop may contain some harmful microorganisms that must be removed in order to produce cerium oxide nanoparticles from tea waste extract using cerium nitrate hexahydrate. The water part after filtering is thrown away because we only need the section containing the tea dust. The sample is then further dried at 50 degrees Celsius in a hot air furnace until it hits the dry powder stage. Figure 1 shows what was done to stop unwanted microorganisms from growing in the tea waste sample. It is then used to produce cerium oxide nanoparticles in a sustainable manner [7].





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Biosynthesis of CeO₂NPs

Cerium (NO₃)₃6H₂0 (25.2 grams) was liquefied in 50 ml of deionized H₂O and stirred for 20 minutes to produce cerium oxide nanoparticles. In the meantime, 1 gramof tea definite leaf powder was mixed with 50 ml of pure water to make an aqueous extract of *Camellia sinensis*. This mixture was then vigorously stirred with a magnetic stirrer for 30 minutes at 60 °C to completely evaporate it, and it was then filtered. Then, the *Camellia sinensis* hull solution was vigorously stirred for 6 to 8 hours at 60 °C while the Cerium (III) Nitrate solution was gradually added. The Staying powder was sintered separately at 300, 400, 500, and 600 degrees Celsius. Eventually, CeO₂ NPs were identified as the yellow powder (Figure 2).

Characterization of cerium oxide nanoparticles:

The approved and suggested Tea waste extract of CeO₂ NPs was examined using a variety of tools and techniques, including UV-Vis spectroscopy analysis.

UV- Vis spectroscopy analysis

With the aid of a Jasco V-560 UV-Vis instrument, UV measurements were made to ascertain the absorption of synthesised CeO_2 NPs from tea waste extract (330–900 nm). The measurements were performed using 1.5 ml of a solution containing CeO_2 NPs. [8].

Applications of CeO₂NPs

It states that the synthesis of CeO₂ NPs showed how lead was removed from the water through the use of tea waste extract. The results were assessed by measuring the optical density (OD) of the synthesized nanoparticles using UV-Vis measurements, as well as the number of colonies developing units on solid medium, bacterial sustainability, and other factors. From the MTT assay method of the experiments were performed to the cytotoxicity studies against Human lung cancer cell line.

Pb 2+ adsorption studies

Standard solutions of a neutral aqueous solution containing 0.6 - 600 g of lead (II) were coupled with 0.3 - 2.0 mL (ideally 1.0 mL) of 4 10-3 M HCl, 3 - 6 mL (preferably 4 mL) of 0.3 M CTAB, and 75 - 130-fold molar excess of a dithizone solution. In order to thin the mixture to the right consistency, deionized water was utilized. Waterways in the environment are being tested for lead concentrations. After being nearly dried up with 10 mL of concentrated HNO3, each 100 mL ambient water sample which had been filtered using Whatman No. 1 was then heated with 10 mL of deionized water to break down the salts. A diluted NH4OH solution was used to neutralize the solution after it had cooled. Following filtering, the resulting solution was quantitatively placed into a calibrated flask measuring 25 mL, and it was then diluted with deionized water to the appropriate level. Using tartrate or thiocyanide as a hiding agent, the lead content of this solution was measured in compliance with the protocol's recommendations after being aliquoted (1-2 mL) into a 10-mL calibrated flask. The absorbance for the identical reagent was measured at 500 nm in relation to a blank [8]. A simultaneous calibration graph was made to determine the lead content of an unidentified sample.

Cytotoxicity studies

From the MTT assay was used for the cellular cytotoxicity studies. A549 (1 104 cells/well) were sown in 96-well plates and given the night to attach. The next morning, varied concentrations of CeO₂ NPs (0-100 g) were presented on a new, fresh medium while the old media were aspirated. The plate spent 8 hours in an incubator. After incubation, MTT solution was added and the incubator was maintained in the dark for 4 hours. The supernatant was removed after 4 hours, and purple formazan was then added. The Enzyme Linked Immuno Sorbent Assay readerthen read the plate at 595 nm. To determine the cellular cytotoxicity of CeO₂ NPs' rare earth metals, the optical density was utilized.





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RESULTS AND DISCUSSION

Much research has been done in the field of bionanotechnology over the past several years with the goal of increasing its diverse activities. Due to its wide variety of biological and physiochemical uses, the rare earth metal CeO₂ NPs made from tea waste extract received particular focus in the current work.

UV-Visible Spectroscopy

The structural characterization of the prepared nanoparticles was measured through the UV-Vis Spectrophotometer approach by calculating absorbance. The UV-visible spectrum of the CeO₂ NPs produced in the current investigation, which included tea waste extract, is shown in figure 3. It shows the typical CeO₂ NP peak, with maximal absorption at 202 and 343 nm. The observed peak value at 343 nm supports the presence of the CeO₂ nanoparticle based on theacquire depak value when compared[9]. Informed that the existence of chemical reagents, such as cerium nitrate hexahydrate employing tea waste extract, produces cerium oxide nanoparticles.

Applications of CeO₂NPs

Absorption study on water samples

Table 1 lists the findings of lead testing on ambient water samples from various sources. The preconcentration of Pb^{2+} is necessary for the majority of spectrophotometric techniques for the measurement of lead in natural water and saltwater [10]. At 500 nm, the absorbance was measured in comparison to a blank for the same reagent. Using a calibration graph that was simultaneously created, the lead level of an unknown sample was ascertained. To lower the lead level, hard water is treated with 100 mg of green CeO_2 NPs nanoparticles per liter of hard water, followed by up to 4 hours of sonication. The results are also calculated using a calorimetric method at 500 nm. Lead levels in drinking water should not exceed 10 g/L, according to the WHO. Using tea waste extract of CeO_2 nanoparticles, Table 2 demonstrates how lead in water is absorbed [11].

Cytotoxicity effect of CeO2 NPs on Human Lung Cancer Cell line (A549)

Despite the experimental research report, the CeO₂ NPs are used in a broad variety of industries, including the biological sciences. The most crucial component of toxicity investigations is nanoceria. They were tested using the MTT test on the A549 cellsfrom the acquired rare earth metal of CeO₂ nanoparticles recovered from tea waste extract. The investigations demonstrate that the IC50 value was determined to be 51.99 g/ml following an 8-hour incubation with MTT solution (Figure 4&5). CeO₂ nanoparticles' cytotoxic effects on a HLC cell line were studied. The dose and duration of treatment affect whether produced nanoparticles induce cytotoxicity [12]. Cell cycle arrest followed by apoptosis may be the cause of the observed cytotoxic effects (Table 3).

Formula Cell viability % = Test OD/Control OD X 100

CONCLUSION

According to that the current knowledge of the research results, cerium nitrate hexahydrate was used as a reducing agent to create CeO₂ nanoparticles from tea waste extract. From the characterization confirmed by UV-visible spectroscopy peak at 343 nm expressed to the concentration of CeO₂ NPs. Spectrophotometry is used to calculate CeO₂NPs ability to absorb lead. The provision of lead-free water to families is the main goal of this project. The inhibitory concentration is 51.99 g/ml, despite the fact that all of the data that have been published have shown that CeO₂ NPs have cytotoxicity activity against the human lung cancer cell line. CeO₂ nanoparticles are a possible alternative anticancer support for lung cancer cells due to their cytotoxicity.





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Conflict of interest

NIL

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Table 1: Determination of lead in different water samples

samples	Lead/μg L–1			
	ADDED	FOUND		
1.Tap water	0	35		
	100	134		
2.well water	0	20		
	100	121		
3.lake water	0	150		
	100	228		

Table 2: Absorption of lead using CeO2NPs

samples	Lead/µgL–1	
	Before ceo2	After good added
	Addition	After ceo2 added
1.Tap water	35	17

Table 3: Cell Viability (%) in different concentration of CeO₂ NPs

S. No	Tested sample concentration (µg/ml)	Cell viability (%) (in triplicates)			Mean Value (%)
1	Control	100	100	100	100
2	500 μg/ml	13.2997	15.1466	11.1111	13.185785
3	400 μg/ml	22.0539	23.4528	25.812	23.772869
4	300 μg/ml	35.5219	31.4332	27.1795	31.378199
5	200 μg/ml	43.6027	43.6482	36.7521	41.334346
6	100 μg/ml	45.6229	52.443	42.0513	46.705725
7	50 μg/ml	47.8114	61.7264	49.4017	52.979847
8	25 μg/ml	54.0404	71.3355	54.8718	60.082568
9	10 μg/ml	68.5185	63.8436	64.6154	65.659184
10	5 µg/ml	78.2828	73.7785	83.5897	78.550358
11	1 μg/ml	88.3838	88.7622	91.1111	89.419055









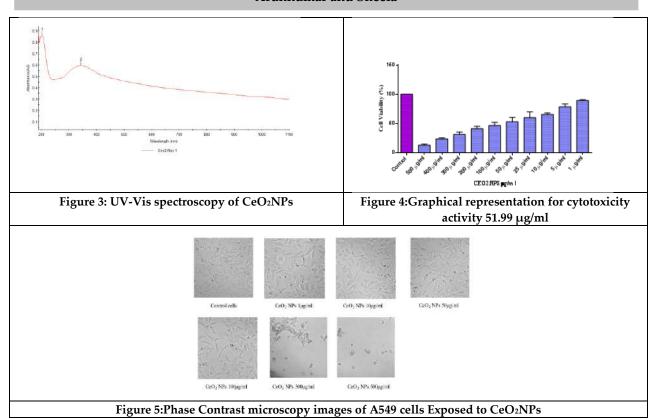
Figure 1: Tea Waste extract

Figure 2: Cerium Oxide Nanoparticles





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RESEARCH ARTICLE

An Efficient Connected Dominating Set based Routing Scheme in Ad **Hoc Wireless Networks**

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ABSTRACT

In ad hoc networks, vertices are inherently mobile, which presents a major challenge in topology constraints. Efficient Connected Dominance Set (ecd-set) has been considered as an efficient solution to solve such problem by building a virtual back bone network to achieve scalability and performance of wireless networks. In ad hoc wireless networks, efficient routing between mobile hosts (also called vertices) is one of the most important functions. A promising approach is routing based on an efficient connected dominating set, in which the search space for a path is reduced to vertices in the set. A cluster is efficiently connected dominant if all vertices in the system are in the cluster or neighbors of vertices in the cluster. To compute efficient connected dominating set in ad hoc wireless networks, where connections of vertices are determined by their geographical distances and quickly find a small efficient connected dominating set. Our approach can be applied to design efficient routing based on efficient connected dominating set for some special ad hoc wireless networks.

Keywords: Ad hoc wireless networks, efficient connected dominating sets, mobile computing, routing,





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INTRODUCTION

Recent advances in technology have provided portable computers with wireless interfaces that allow network communication between mobile users. The resulting computing environment, often referred to as mobile computing [1], does not require users to maintain a fixed and globally known position on the network and enables virtually unrestricted mobility. An ad hoc wireless network is a special type of wireless network in which a collection of mobile hosts with wireless network interfaces can form an ad hoc network without the aid of any established infrastructure. If only two hosts located close to each other in wireless transmission range are involved in an ad hoc wireless network, no actual routing protocol or decision is required. However, if two hosts wishing to communicate are outside their wireless transmission ranges, they can only communicate if other hosts in the ad hoc wireless network are willing to send them packets.

For example, in the network shown in Figure 1, mobile host v_3 is out of range of host v_1 wireless transmitter (indicated by the circle around v_1) and host v_1 is out of range of host v_3 wireless transmitter. If v_1 and v_3 want to exchange packets, v_2 can use host v_2 to send packets to v_1 and v_3 because there is overlap between their ranges. A simple graph G = (V, E) can be used to represent an ad hoc wireless network, where V represents the set of wireless mobile hosts and E represents the set of edges. An edge between host pairs $\{v, u\}$ indicates that both hosts v and v are within range of their wireless transmitters. To simplify our discussion, we assume that all mobile hosts are identical, that is, their wireless transmitter ranges are identical. In other words, if E has an edge $e = \{v, u\}$, it implies that v is in the range of v and v is in the range of v. So the corresponding graph is an undirected graph. The diagram in Figure 2 represents the corresponding ad hoc wireless network in Figure 1.

Routing in ad hoc wireless networks presents special challenges. In general, the main characteristics of mobile computing are low bandwidth, mobility and low power. Wireless networks offer less bandwidth than wired networks, and therefore, information collection is more expensive. The movement of hosts, which causes changes in the underlying network topology, also increases the volatility of network information. In addition, the limitation of power leads users to disconnect the mobile unit frequently in order to save power consumption. This feature can introduce more failures (also known as switch on/off) in mobile networks, which may consider edas a special operation. The paper is organized as follows: Section 2 presents related work and preliminaries. Several practical issues are also discussed. The proposed approach to efficient connected dominating routing is discussed in Section 3. Section 4 presents the proposed method for efficient. A hierarchical formulation of the hierarchical architecture of efficient connected dominant set reduction using some special ad hoc networks and ideas for hierarchical routing is discussed in Section 5 and the paper concludes in Section 6.

Related Work and Preliminaries

Dominating sets are important tools used in allocating limited resources to massively parallel architectures. Dominating sets are used in allocating backups, sending codes, and communication networks. Dominant set based routing [2] is a promising routing approach in ad hoc networks. A subset of vertices of a graph is a dominating set if every vertex not in the subset is adjacent to atleast one vertex in the subset. Also, this dominating set must be combined to facilitate the routing process within an induced graph defined as containing only dominating vertices. Vertices in the domination set are also called gateway hosts, while vertices outside the domination set are called nongateway hosts. Unfortunately, finding the minimal connected dominating set is NP-complete for most graphs. A simple and efficient distributed algorithm that can quickly determine the connected dominating set in ad hoc networks. This approach uses a localized algorithm called a labeling process in which hosts interact with others in the neighborhood. In particular, each host is labeled true if it has two unconnected neighbors. Collectively these hosts have been shown to achieve the desired universality, with the set of labeled hosts forming a small connected





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dominating set To represent an ad hoc network, we can use a unit disk graph [3] G = (V, E), where V represents the set of wireless mobile hosts and E represents the set of edges. An edge between a host pair $\{u, v\}$ indicates that both hosts u and v are within range of their wireless transmitters. In Figure 3 (b), hosts u and v form a connected dominating set of a given unit disk graph. Cluster-based routing [4] is a convenient method for routing in ad hoc wireless networks. In an ad hoc wireless network, adjacent hosts form a cluster or a clique, which is a complete subgraph. Each cluster has one or more gateway hosts to connect other clusters in the network. Gateway hosts (from different clusters) are typically connected. Note that gateway hosts form the dominant cluster [5] of the corresponding ad hoc wireless network. A subset of vertices of a graph is a dominating set if every vertex not in the subset is adjacent to atleast one vertex in the subset. Moreover, this dominating set should be combined for simplicity of the routing process into a reduced graph containing only dominating vertices. We refer to all approaches that use gateway hosts to form a dominating set as dominating set based routing. The main advantage of connected dominating set based routing is that it simplifies the routing process in a small subnetwork formed from a connected dominating set. This means that only gateway hosts should have routing information. A mathematical based performance comparison of TUS and triple connected domination sets for MANET [6-9]. A subset $\,S\,$ of $\,V\,$ of a nontrivial graph G is said to be an efficient connected dominating set, if every vertex is dominated exactly once. The minimum cardinality taken over all efficient connected dominating sets is called the efficient connected domination number and is denoted by γ_e . The main advantage of efficient connected dominating set based routing is that it simplifies the routing process in a small subnet work formed from an efficient connected dominating set.

This means that only gateway hosts need to keep routing information in a proactive approach and the search space is reduced to a dominant set in a reactive approach. In active routing, routes to all destinations are computed a priori and maintained in the background through a periodic update process. In reactive routing, the route to a specific destination is calculated "on demand"; that is, only when necessary. Clearly, the effectiveness of this approach depends on the process of identifying and maintaining an efficient connected dominant set and the size of the associated subnet work. The efficient connected dominating set under consideration is obtained from the labeling process and is further reduced by various reduction methods proposed in this paper. The main contributions of the paper include the locality property of the labeling process. That is, a change in host status, gateway (dominating) or non-gateway (dominated)), affects only the status of restricted adjacent hosts. We show different local properties of gateway/non-gateway obtained by different versions of the labeling process. Node connections in an ad hoc wireless network are determined based on their geographic distance in 2-D or 3-D space. That is, two nodes are connected if their geographic distance is within a given wireless transmission range. We study some properties of the obtained efficient connected dominating set. We show that the proposed approach outperforms and outperforms a classical approach in finding a small efficient connected dominating set. We also discuss ways to update/recalculate the efficient connected dominating set when the base graph changes with the movement of mobile hosts. Efficient routing in ad hoc wireless networks is described based on the obtained efficient connected dominating set.

Efficient connected dominating set proposed approach

As mentioned at the beginning, we will focus on building an efficient connected dominating set. Listed below are some of the desirable features for a dominant suite:

- The creation process should be distributed and simple. Ideally, this requires only local information and a constant number of message exchanges between neighboring hosts.
- Consequently the efficient connected dominating set must be connected and close to the minimum.
- The resulting efficiently connected dominating set must contain all intermediate nodes of the shortest path. In
 this case, the all pair shortest paths algorithm should be applied only to the subnetwork formed from the
 dominating set.





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Labeling process

We propose a labeling process that marks each vertex in a given connected and simplified graph G = (V, E). m(v) is a label for a vertex $v \in V$, which is either T (labeled) or F (unlabeled). We will show later that the labeled vertices form an efficient connected dominating set. We assume that all nodes are initially unlabeled. $N(v) = \{u/\{v,u\} \in E \text{ denote the open neighborhood set of vertex } v.$ Initially v is equal to N(v).

- 1. Initially assign a label F to each v in V.
- 2. Each ν exchanges its open neighbor set $N(\nu)$ with all its neighbors.
- 3. Each v assigns its label m(v) to T if there are two unconnected neighbors.

In the example of Figure 1 , $N(V_1) = \{V_2, V_4\}$, $N(V_2) = \{V_1, V_3, V_4\}$, $N(V_3) = \{V_2, V_5\}$, $N(V_4) = \{V_1, V_2\}$, and $N(V_5) = \{V_3\}$. After step 2 of the labeling process, vertex V_1 has $N(V_2)$ and $N(V_4)$, V_2 has $N(V_1)$, $N(V_3)$ and $N(V_4)$, V_3 has $N(V_2)$ and $N(V_5)$, V_4 has $N(V_1)$ and $N(V_2)$, and V_5 has $N(V_3)$. Based on step 3, only vertices V_2 and V_3 are labeled T.

Property 1 Given a connected graph G that is not fully connected, the vertex subset $V^{'}$ obtained from the labeling process forms an efficient connected dominating set of G.

Property 2 The shortest path between any two vertices does not include any non-gateway vertex as an intermediate host

Since the problem of determining the minimum efficient connected dominating set of a given connected graph is NP-complete, the efficient connected dominating set obtained from the labeling process is usually not minimal. In some cases, the resulting dominating set is trivial; That is, that is, $V^{'}=V$. For example, any vertex-symmetric graph will generate a non-trivial dominating set using the proposed labeling procedure. However, the labeling process is efficient for ad hoc networks, where the corresponding unit disk graph forms a set of localized clusters (or cliques). The stages of evolution of connection rules for private networks are to achieve two important rules:

- a) Find an ECDS.
- b) Minimize number of ECDS as much as possible.

The following stages of development are:

Basic Rules

- Transmission of all nodes that is approximately similar or equally distributed.
- (ii) Communication between all nodes in the network, but enabled by a third node called ECDS.

Formulation of the above algorithm by Wu & Li

a) If any two nodes $u, v \in V$ are dominating sets, $N[v] \subseteq N[u]$ and id(v) < id(u), then convert m(v) to F. b) Any three nodes $u, v, w \in V$ dominating sets, where u and w are two labeled neighbors of v. Let $N[v] \subseteq N[u] \cup N(w)$ and id(v) < id(u), and id(v) < id(w), convert m(v) to F. Where $N[v] \cup \{v\} = N[v]$, which is the closed neighborhood set of v. Another condition is to assign a unique ID, id(v), to each vertex in the dominating set [10].

Proposed method for efficient connected dominating set

Labeling processes are useful only if some nodes have new/broken connections with host v. When there are many such nodes, the best way to update the gateways is like a host switch on/off. During its operation, host v continuously sends its open neighbor system N(v) with the signal $\{id(v), Heat_Beat\}$. This prompts each host $w \in v \cup N(v)$ to update its gateway state. The relevant update process may be as follows:





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- 1. Mobile host v periodically exchanges its open neighbor configuration with all its neighbors every τ time interval.
- 2. Each host $w \in v \cup N(v)$ assigns its label m(w) to T if it has two disjoint neighbors.
- 3. Whenever there is a newly labeled gateway, the newly labeled gateway host and its gateway neighbors use rules (i) and (ii) to reduce the number of gateway hosts. For host u, which has a broken link to host v, its gateway status is updated once it detects that the link is broken. The relevant update process may be as follows:
- 4. The mobile host u detects a broken link to v and exchanges its open neighbor status with all its neighbors.
- 5. If host u is a non-gateway, it simply does nothing further; Otherwise, host u assigns its label m(u) to F if all its neighbors are pairwise connected.

Domination set based routing usually consists of three steps:

- 1. If the source is not a gateway host, it forwards packets to a source gateway, which is one of the nearest gateway hosts.
- 2. This source gateway acts as a new resource to route packets in the induced graph formed from the efficient connected dominating set.
- Finally, the packets reach the destination gateway, which is the destination host or the gateway connecting the destination host. In the latter case, the destination gateway forwards the packets directly to the destination host.

Each gateway host maintains the following information: a gateway domain membership list and a gateway routing table. A gateway domain membership list is a list of non-gateway hosts that are adjacent to a gateway host. The gateway routing table includes an entry for each gateway host, along with its domain membership list. Figure 4 shows the four gateway hosts 4, 7, 8 and 9 obtained from the extended labeling process. Arrowed lines correspond to unidirectional edges and solid lines represent bidirectional edges. A bilateral edge fv; ug can be considered as two concentric edges (v; u) and (u; v). Figure 5 (a) shows that host 8 has three members 3, 10, 11 in its gateway domain membership list. Figure 5 (b) shows the gateway routing table at host 8, which contains a set of entries for each gateway along with its membership list. Other columns of this table, including distance and routing information, are not shown. The way routing tables are constructed and updated may be different in a subnetwork formed from an efficient connected dominating set. In the following, we briefly discuss two extreme cases of routing protocols: shortest path routing and dynamic source routing.

Properties

Let V is be the set of vertices labeled T in V such that $V = \{v/v \in V, m(v) = T\}$. A reduced graph G is a subgraph of G induced by V such that G = G[V]. The following two theorems show that G is an efficient connected dominating set of G and that it is connected.

Theorem 1. A graph G = (V, E) is connected, but not fully connected, the vertex subset V obtained from the labeling process forms an efficient connected dominating set of G.

Proof. Choose a vertex in G at random. We show that v is in V (the set of vertices in V denoted T) or is near a vertex in V. Suppose that v is labeled F, and if atleast one neighbor is labeled T, the theorem is proved. If all its neighbors are labeled F.





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We consider the following two cases

• All other vertices in G are neighbors of v. Given the labeling process and m(v) = F, all these neighbors must be pairwise connected, i.e., G is fully connected. This contradicts the assumption that G is not fully connected.

• Let G contains at least one vertex u that is not adjacent to vertex v. Construct a short path, $(v, v_1, v_2,, u)$, connecting vertices v and u. Since G is a connected graph such a path always exists. Note that v2u when v and u are distance-2 in G, that is, disG(u,v)=2. Also, v and v_2 are disjoint; Otherwise, $(v,v_2,....,u)$, is a shortest path connecting v and v. Based on the labeling procedure, vertex v_1 , its neighbors v and v_2 should both be labeled as v. Again this contradicts the assumption that all neighbors of v are labeled v. When a given graph v0 is fully connected, all vertices are denoted v1. This makes sense because if all vertices are directly connected, gateway hosts are not needed.

Theorem 2. A reduced graph G = G[V] is a connected graph.

Proof. We prove this theorem by contradiction. ν assuming that G is disconnected And you are two intersecting vertices in G.

Assume disG(u,v) = k+1 > 1 and $(v,v_1,v_2,....,v_k,u)$, is the shortest path between vertices v and u in G. Clearly, all $v_1,v_2,....,v_k$ are unique and they contain at least one v_i such that $m(v_i) = F$ (otherwise, v and v_i are connected in v_i . On the other hand, no two adjacent vertices of v_i,v_{i+1} and v_{i+1} are connected in v_i . Otherwise, v_i is not a shortest path. Hence, by the labeling process v_i is pringed up a contradiction. Vertices in the efficient connected dominating set are called gateway nodes and nodes outside the efficiently connected dominating set are called non-gateway nodes. The next theorem shows that, except for the source and destination nodes, all intermediate nodes along the shortest path are in the efficient connected dominating set derived from the labeling process.

Theorem 3.The shortest path between any two nodes does not include any non-gateway node as an intermediate node.

Proof. We prove this theorem by contradiction. Suppose a shortest path between two vertices v and u includes a non-gateway node v_i as an intermediate node, in other words, this path is $(v,, v_{i-1}, v_i, v_{i+1},, u)$. We label the vertex before v_i on the path as v_{i-1} , Similarly, the vertex following v_i in the path is v_{i+1} . Since vertex v_i is a non-gateway node, i.e., $m(v_i) = F$, there must be a connection between v_{i-1} and v_{i+1} . Hence, we find a shortest path between v and v_{i+1} and v_{i+1} and v_{i+1} are the problem of determining the minimal efficient connected dominating set of a given connected graph is NP-complete, the efficient connected dominating set obtained from the labeling process is usually not minimal. In some cases, the resulting efficient connected dominating set is trivial,

i.e.,
$$V$$

$$= V \text{ or } V'$$

Hierarchical structure of efficient connected dominating set reduction using for some special ad hoc networks

An important issue in the design of a hierarchical structure is determining the correct hierarchy. In an ad hoc wireless network, each host can roam without speed and distance limitation. To further reduce power consumption, mobile



^{= {}.} For example, any vertex-symmetric graph will generate a non-trivial efficient connected dominating set using the proposed labeling process. However, the labeling process is efficient for ad-hoc wireless mobile networks, where the correlation graph forms a set of localized clusters (or cliques). Our simulation results confirm this observation.



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hosts can be switched off and on again at any time. We can summarize the topological changes of an ad hoc wireless network into three different categories: mobile host switch on, mobile host switch off, and mobile host movement. The challenge here is when and how each host should update/recalculate the gateway information. Gateway update means that only individual mobile hosts update their gateway status. Gateway recalculation means that the entire network recalculates the gateway/non-gateway status. Gateway recalculation may be a better approach if there are many mobile hosts operating in the network, i.e., the dominant and absorbing set are recalculated afresh. On the other hand, if only a few mobile hosts are active, the gateway information can be updated locally. When mobile host u switches on, its non-gateway neighbors must also update their state along with host u, since any gateway neighbor remains a gateway even after a new vertex u is added. For example, in Figure 6 (a), when host u switches on, the status of gateway neighbor v is not affected because atleast two of v neighbors are w_1, w_2 and w_3 are initially unconnected and these connections are not affected when host v to mark itself as a gateway, depending on the connectivity between the neighbors of host v and v and v and v and v and v and v and v are link can be unidirectional or bidirectional.

Efficient Connected Dominating Set reduction using for some special ad hoc networks.

- 1. The Möbius-Kantor graph is a symmetric bipartite cubic graph with 16 vertices and 24 edges as shown in Figure 7. Mobius-Kantor graph G, $\gamma_{ecd}(G) = 8$. Here $S = \{v_1, v_2, v_3, v_4, v_5, v_6, v_7, v_8\}$ is an efficient connected dominating set. Figure 7 is obtained from the labeling process representing eight gateway hosts $v_1, v_2, v_3, v_4, v_5, v_6, v_7$ and v_8 .
- 2. The Chvátal graph is an undirected graph with 12 vertices and 24 edges as shown in Figure 8. For a Chvátal graph G, $\gamma_{ecd}(G) = 4$. Here $S = \{v_1, v_2, v_3, v_4\}$ is an efficient connected dominating set. Figure 8 is obtained from the labeling process representing four gateway hosts v_1, v_2, v_3 and v_4 .
- 3. The Dürer graph is an undirected graph with 12 vertices and 24 edges as shown in Figure 9. For a Dürer graph raph G, $\gamma_{ecd}(G) = 6$. Here $S = \{v_1, v_2, v_3, v_4, v_5, v_6\}$ is an efficient triple connected dominating set. Figure 9 is derived from the labeling process representing four gateway hosts v_1, v_2, v_3, v_4, v_5 and v_6 .
- 4. Any path connected by a pendant edge at each vertex is called a Hoffman tree and is denoted by Pn+ as shown in Figure 10.
- 5. For a Hoffman tree G, $\gamma_{ecd}(G) = 4$. Here $S = \{v_1, v_2, v_3, v_4\}$ is an efficient connected dominating set. Figure 10 shows the eight gateway hosts v_1, v_2, v_3 and v_4 obtained from the labeling process.
- 6. The above special ad hoc networks resulting efficient connected dominating set must be connected and close to the minimum and all intermediate nodes of any shortest path. An all-pair shortest path used for a subnet formed from an efficient connected dominating set.

CONCLUSIONS

The efficient connected dominance set based routing in ad hoc wireless networks with undirected links. This approach is based on finding an efficient connected dominating set in an undirected graph representing the topology of an ad hoc wireless network. A labeling process is provided that can quickly identify such a core and easily update it in a changing environment. Although it is unlikely that efficient connected dominating set based routing will solve all the important problems of routing in ad hoc wireless networks, we believe that it offers a very promising and unique combination of several existing approaches combined with innovative application. A reduced graph can be constructed from an efficient connected dominating set and the search space for the routing process can be reduced to this reduced graph. Shortest path routing and dynamic source routing have been used to illustrate this approach.



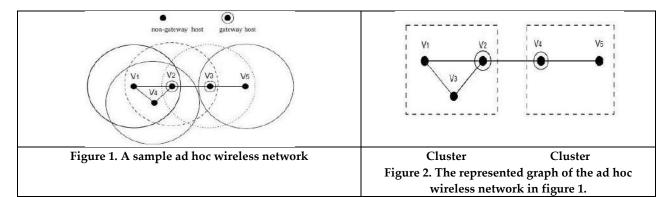


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The future work will extend the proposed different types of connected domination set to ad hoc wireless networks where mobile hosts have different transmission radii. Another future research direction is to iteratively apply the proposed approach to subgraphs generated from different types of connected dominating sets to form a hierarchy of connected dominating sets. Focuses on implementation of connected dominating set based routing design details and validation of design performance through extensive variety of connected dominating set for ad hoc networks.

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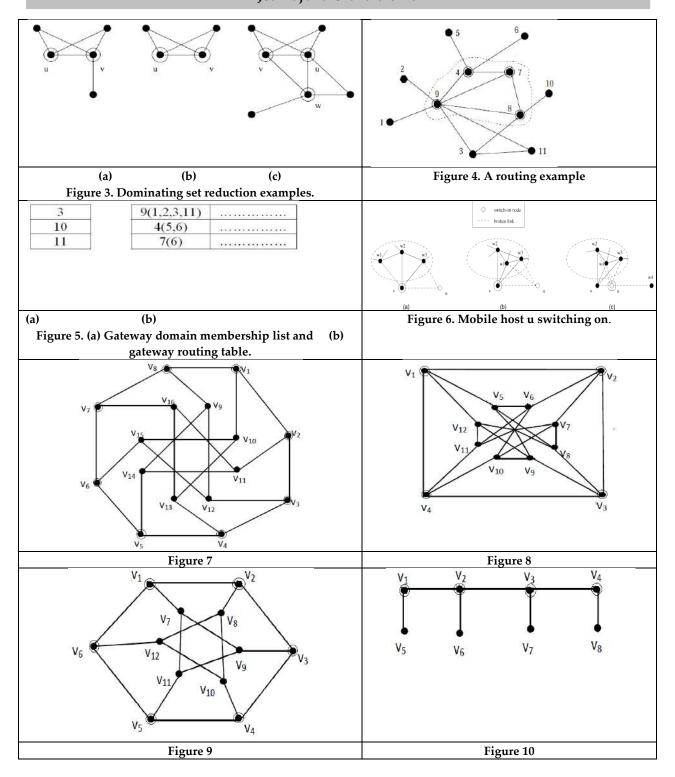
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RESEARCH ARTICLE

AI-Powered Insights: Unraveling Consumer Adoption Trends in Renewable Energy Technologies, with a Focus on Solar Panels and **Alternative Electricity Sources**

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ABSTRACT

This study delves into the dynamic landscape of consumer adoption trends in renewable energy technologies, with a particular emphasis on solar panels and alternative electricity sources, guided by insights derived from artificial intelligence (AI). As societies navigate towards a sustainable energy future, understanding consumer behaviors and preferences becomes paramount. Leveraging AI-powered methodologies, this research unveils nuanced patterns and motivations driving consumer choices in the realm of renewable energy. By analyzing vast datasets and employing advanced algorithms, this study provides comprehensive insights into the factors influencing consumer attitudes and adoption rates. The research examines not only the widespread adoption of solar panels but also explores emerging trends in alternative electricity sources such as wind, hydro, and geothermal energy. Through AI-driven analysis, this study sheds light on the intricate interplay between technological advancements, consumer perceptions, and market dynamics within the renewable energy sector. The findings offer valuable implications for policymakers, industry stakeholders, and researchers seeking to accelerate the transition towards a more sustainable energy ecosystem.

Keywords: artificial intelligence, algorithms, consumer, researchers, stakeholders, technologies.





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INTRODUCTION

Government regulations, finances, and weather conditions are some of the elements that have an impact on the development of solar energy in India. Renewable energy is defined as energy derived from natural resources like wind, sunshine, geothermal, etc. They are essential due to the scarcity of non-renewable energy sources including coal, oil, gasoline, diesel, and other fossil fuels. The most accessible form of energy is solar energy. This article discusses consumer perceptions of solar power and alternative energy sources. In order to predict the solar cell's performance under varied circumstances, it is critical to understand how temperature and irradiance affect it. Photovoltaic = Sunlight → Electricity through a solar cell. Every day, the sun gave off a tremendous quantity of energy. It is pollution-free and has no negative effects on the environment. To solve their battery problems, several calculators use solar cells. It is economical since solar energy has no production costs. As photovoltaics can generate energy even in low light, there is no need to be concerned about the availability of electricity on rainy or overcast days. These days, solar energy is a widely popular type of energy. Solar energy is used by many homes, businesses, offices, institutions of higher learning, and shops. When used for a large population, it is incredibly beneficial. Tropic of Cancer passes through the middle of the country, so we need not worry about sunlight. The raw material for making solar cells is silicon and it is very limited. 85-90% of silicon is imported to India and it is the major reason why the initial cost of Solar energy setup is high.

Solar energy is the renewable energy source in India that is growing the fastest, followed by wind energy. In India, there were 56.95 GW of solar installations as per the most recent statistics from June 2022. In India, there are close to 42 solar parks. The state with the greatest installed capacity in Karnataka, followed by Rajasthan and Tamil Nadu. The major issue is the acquisition of land. Every 40–60 MW of generation requires at least 250 acres of land. The Ministry of New and Renewable Energy has administrative jurisdiction over the SOLAR ENERGY CORPORATION OF INDIA (SECI) (MNRE). India is the third-largest energy consumer in the world and ranks third in the attractiveness of countries for renewable energy. In the last 7.5 years, the capacity of all installed renewable energy has expanded by 286 percent, and in the last 7 years, the capacity of all installed solar energy has increased by 17 times.

• Wind power: 40.08 GW

• Solar: 49.34 GW

Bio Power: 10.61 GW

• Hydro: 51.34 GW

A 30 GW hybrid wind-solar project is being installed in Gujarat. This will be the largest renewable energy park in the world once it is implemented. A program known as Solar City encourages the local government to use renewable energy sources. The implications of the developed technologies for the development of renewable energy and sustainability are encouraging. The corporation can develop better plans, generate higher earnings, and maintain its competitive edge in the market by researching the solar panel industry.

The main need for the study is

- To know how useful the solar panels are to the customers and their benefits as well.
- To find consumers' behaviour towards solar panels, other sources of electricity, and factors influencing their buying.
- To find the factors that affect the consumer purchase intentions in purchasing or installation of solar energy sources at the domestic level.

The main objectives of the study is

- To evaluate the customer preference in the major cities.
- To analyze the pattern of customer buying habits while purchasing solar panels.





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- To understand the consumer's preference and behavior towards buying solar panels and other sources of electricity.
- To understand the underlying problems involved in the industry.
- To check the success and growth of the solar business the in future.

LITERATURE REVIEW

Consumer attitudes towards domestic solar power systems by Adam Faiers, Charles Neame:

This study, conducted in central England, investigates household attitudes towards solar power systems. Employing the Diffusion of Innovations theory, it identifies barriers to adoption and examines how various system attributes influence consumer perceptions. Factors such as cost, reliability, and perceived benefits are analyzed to understand the reluctance of the 'early majority' to adopt solar technology.

Major Factors Influencing on the Growth of Solar Energy Usage in India by Jayanta Ghosh, A. Seetharaman, K. Maddulety:

Focusing on India's solar energy sector, this research identifies and analyzes four primary factors driving its growth. It underscores the pivotal role of government policies, local community participation, availability of finance, and climatic conditions in fostering solar energy adoption. The study highlights the positive correlation between these factors and the expansion of the solar energy market in India.

Consumer attitudes towards renewable energy in China -The case of Shanghai by Aira Hast, Behrang Alimohammadisagy and, Sanna Syri:

A survey conducted in Shanghai provides insights into consumer attitudes towards renewable energy, with a focus on solar power. Using generalized linear regression models, the study reveals that age, perceived renewable energy potential, and economic factors significantly influence consumers' willingness to invest in renewable energy systems. Additionally, barriers such as upfront costs and maintenance concerns are identified, indicating areas for intervention to promote adoption.

The Factors Affecting the Performance of Solar Cells (ICAET 2015):

This article delves into the technical aspects of solar energy, specifically the factors influencing the performance of solar cells. It elucidates the impact of temperature and irradiance variations on solar cell efficiency, emphasizing the importance of understanding these parameters for optimizing solar module performance. By providing insights into the effects of ambient conditions on solar cell performance, the study contributes to enhancing the efficiency and reliability of solar energy systems.

Consumer Preferences for Solar Energy: A Choice Experiment Study by Mamkhezri, Jamal & Thacher, Jennifer & Chermak, Janie:

Focusing on consumer preferences in the United States, this study employs choice experiments to assess consumers' willingness to pay for solar energy. It considers various factors such as location, exposure to solar installations, and preferences for different types of solar energy sources (rooftop versus solar farm). The findings underscore the importance of consumer preferences and location heterogeneity in shaping solar energy adoption strategies.

Synthesis:

Together, these studies provide a comprehensive understanding of consumer attitudes and influential factors in solar energy adoption. While government policies, local participation, and economic considerations play crucial roles in driving adoption, consumer perceptions and preferences also significantly influence decision-making. By addressing barriers and leveraging drivers identified in these studies, policymakers and stakeholders can develop targeted interventions to accelerate the adoption of solar energy and facilitate the transition to a sustainable energy future.





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METHODOLOGY

The research methodology employed in this study is descriptive in nature, aiming to characterize the variables of interest within a specific context. Primary data collection was conducted through a quantitative approach, utilizing a questionnaire administered to a sample size of 108 students. The sampling technique employed was non-probability (random) sampling, where individuals were selected without every member of the population having an equal chance of inclusion. Specifically, convenience sampling was utilized, allowing for the selection of respondents based on their availability and accessibility to the researcher. This approach facilitated data collection in a practical and efficient manner, although it may introduce potential biases due to the non-random selection process. Overall, the combination of descriptive research design and primary quantitative data collection methodology provided valuable insights into the variables under investigation within the study's scope.

DISCUSSIONS

According to the survey results, an overwhelming majority, accounting for 89.80% of respondents, demonstrated awareness of solar panels and their associated technologies. Conversely, a minority, comprising 10.18% of participants, indicated a lack of awareness regarding solar panels and their technological aspects. These findings underscore a substantial level of familiarity among the surveyed population with solar energy systems, highlighting the importance and pervasiveness of solar technology knowledge in the surveyed demographic. Also purchase cost emerged as the most influential factor affecting consumers' decisions to switch to solar panels, with 49% indicating high influence, followed by 32% moderately influenced. Maintenance cost closely followed, with 47% reporting high influence and 35% moderately influenced. Ease of switching garnered mixed responses, with 30%, 32%, and 35% of consumers reporting high, moderate, and neutral influence, respectively. Appearance played a significant role, with 14% highly influenced, 27% moderately influenced, and 43% neutral. Incentives for switching also showed a mixed response, with 22% highly influenced, 31% moderately influenced, and 34% neutral. Family and friends' opinions varied, with 18% highly influenced, 31% moderately influenced, and 33% neutral, while 16% were slightly influenced and 10% reported no influence. These findings highlight the multifaceted nature of consumer decision-making regarding the adoption of solar panels, influenced by various factors such as cost, maintenance, aesthetics, incentives, and social perceptions.

Based on the primary data collected, various reasons were cited by respondents for not having solar panels at home or business. A significant portion, accounting for 30.5% of participants, expressed concerns over the perceived high cost of solar panels, deeming them too expensive for an energy-saving product and thus not worthwhile. Additionally, 33.3% indicated a lack of knowledge on how to initiate the process, reflecting a barrier to entry stemming from insufficient information or guidance. Conversely, 16.6% of respondents already possessed solar panels, indicating prior adoption. Meanwhile, 10.18% chose the option citing the process of obtaining solar panels as difficult, and 9.2% expressed concerns about reliability or safety issues. These insights underscore the multifaceted considerations influencing individuals' decisions regarding solar panel adoption, encompassing cost, knowledge, existing ownership, perceived complexity, and safety apprehensions.

The study indicates a pronounced inclination towards solar panel adoption among respondents, especially among those aged below 50, with a notable concentration (90%) in the 18-30 age bracket, reflecting a forward-looking perspective among the younger demographic. Despite predominantly urban representation (55.55%), the survey encompasses diverse backgrounds, including metropolitan, suburban, and rural respondents. While a significant majority (76.85%) currently lack solar panel installations, citing cost concerns and perceived complexity as primary deterrents, there's a prevailing belief (95%) in solar panels' potential to foster sustainable living and long-term cost savings. Despite respondents' modest familiarity with government solar policies, there's a strong consensus (94%) advocating for solar energy adoption, citing environmental benefits and reduced energy costs as compelling factors.





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Identified challenges include awareness gaps, maintenance and installation costs, and resistance to change. Notably, respondents perceive educational initiatives and social media advocacy as pivotal for promoting solar energy usage. Additionally, factors such as purchase and maintenance costs, ease of switching, family/friends' opinions, incentives, and appearance play varying roles in influencing individuals' decisions to transition to solar panels, underlining the multifaceted considerations shaping consumer preferences and behaviors in the renewable energy landscape. The findings from the primary data analysis shed light on the diverse factors influencing individuals' decisions regarding the adoption of solar panels for residential or business use. The significant proportion of respondents expressing concerns over the high cost of solar panels highlights a key barrier to widespread adoption, with affordability emerging as a critical consideration for prospective consumers. Moreover, the substantial percentage of participants indicating a lack of knowledge on how to initiate the process underscores the importance of education and awareness campaigns to facilitate informed decision-making and promote solar energy uptake.

Conversely, the presence of a notable portion of respondents who already possess solar panels suggests a level of familiarity and acceptance within the surveyed population, indicating a degree of successful adoption within certain segments. However, challenges persist, with a sizeable percentage identifying the process of obtaining solar panels as difficult and expressing concerns about reliability or safety issues. Addressing these challenges will be crucial for overcoming barriers to adoption and fostering greater uptake of solar energy solutions. The exploration of consumer adoption trends in renewable energy technologies, particularly focusing on solar panels and alternative electricity sources, yields significant insights with implications for various stakeholders. The utilization of AI-powered methodologies has facilitated a deeper understanding of consumer behaviors and preferences, offering valuable guidance for decision-making and strategic planning in the renewable energy sector.

Implications

Market Strategies: The study's findings can inform market strategies tailored to enhance consumer adoption of renewable energy technologies. By identifying key drivers and barriers to adoption, stakeholders can develop targeted marketing campaigns and incentives to promote the uptake of solar panels and alternative energy sources.

Policy Formulation: Policymakers can leverage the insights gleaned from the study to formulate effective policies aimed at incentivizing renewable energy adoption. This may include implementing financial incentives, streamlining permitting processes, and investing in infrastructure to support renewable energy integration into the grid.

Investment Opportunities: The identification of consumer preferences and attitudes towards renewable energy technologies can guide investment decisions in the renewable energy sector. Investors can capitalize on emerging trends and consumer demand to allocate resources strategically, fostering innovation and growth in the renewable energy market.

CONCLUSIONS

The study underscores the growing importance of renewable energy technologies, particularly solar panels and alternative electricity sources, in meeting global energy needs and addressing climate change challenges. By unraveling consumer adoption trends through AI-powered insights, the study highlights the significant role that consumer preferences and perceptions play in shaping the renewable energy landscape. In conclusion, the findings of this study emphasize the need for concerted efforts from policymakers, industry stakeholders, and investors to accelerate the transition towards renewable energy. By aligning market strategies, policies, and investments with consumer preferences and trends, stakeholders can drive widespread adoption of renewable energy technologies, contributing to a sustainable and low-carbon future.





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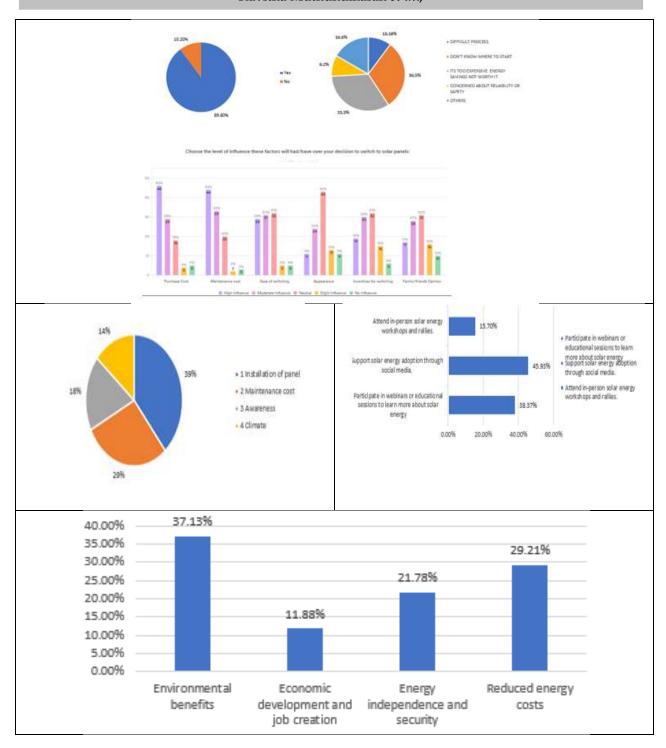
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RESEARCH ARTICLE

Global Outreach Research Activities and Changing Trends in Pediatric Obstructive Sleep Apnea. A Bibliometric Analysis

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ABSTRACT

The most prevalent risk factors for obstructive sleep apnea (OSA) in children are hypertrophy of the tonsils and adenoids. This is closely followed by obesity and craniofacial traits such as "choanal atresia", "micrognathia", "thin palatal arch", "dolichofacial pattern", "macroglossia", and "retrognathia". The core concept of Obstructive Sleep Apnea (OSA) is around an atypical tendency of the upper airway to collapse while an individual is asleep, resulting in modified breathing patterns and disruptions in sleep. The aforementioned disruptions encompass awakenings from sleep, fragmentation of sleep, and perturbations in the regular homeostatic gas exchange

Keywords: This is closely followed by obesity and craniofacial traits such as "choanal atresia", "micrognathia", "thin palatal arch", "dolichofacial pattern", "macroglossia", and "retrognathia".

INTRODUCTION

Obstructive sleep apnea (OSA) is a ubiquitous public health concern, impacting a range of individuals. It affects an estimated 1% to 6% of children [1-2], with a higher prevalence of up to 59% observed in obese children [3-5]. In adults, OSA affects around 2% to 24% of the population, while an overwhelming 70% of those who undergo bariatric





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surgery experience this condition [6]. The prevalence of the condition rises in correlation with advancing age, resulting in substantial financial burdens in the form of both direct and indirect healthcare expenditures, amounting to billions of dollars [7]. The most prevalent risk factors for obstructive sleep apnea (OSA) in children are hypertrophy of the tonsils and adenoids. This is closely followed by obesity and craniofacial traits such as "choanal atresia", "micrognathia", "thin palatal arch", "dolichofacial pattern", "macroglossia", and "retrognathia". The core concept of Obstructive Sleep Apnea (OSA) is around an atypical tendency of the upper airway to collapse while an individual is asleep, resulting in modified breathing patterns and disruptions in sleep. The aforementioned disruptions encompass awakenings from sleep, fragmentation of sleep, and perturbations in the regular homeostatic gas exchange. Paediatric Obstructive Sleep Apnea (POSA) in children is a complex condition that involves several factors and a sophisticated interplay between hypertrophy of the tonsils, craniofacial constraints, and changes in the tonicity of the neuromuscular system [8-10]. Infants diagnosed with craniofacial disorders exhibit a heightened susceptibility to airway blockage as a result of anatomical irregularities, while infants affected by neuromuscular illness mostly experience obstruction owing to hypotonia [11]. The therapy of obstructive sleep apnea (OSA) in paediatric populations necessitates particular attention, given that it is not linked to modifiable risk factors that may be addressed by lifestyle modifications. The management of mild cases of paediatric obstructive sleep apnea (OSA) might involve the utilization of a combination of intranasal glucocorticoids and leukotriene inhibitors.

These therapeutic interventions have demonstrated efficacy in enhancing the "apnea-hypopnea index (AHI)".[12-13] "Adenotonsillectomy" is a viable treatment option for the alleviation of symptoms in the majority of children with tonsillar hypertrophy, despite the potential surgical morbidity and risk of recurrence that must be acknowledged and accepted [14]. While CPAP has proven to be a successful approach in treating adults, its implementation in children is challenging because to low compliance rates [15,16]. The orthodontic treatment of class II abnormalities has demonstrated its value as a viable alternative, which may be achieved by either quick palatal expansion or the use of oral devices that facilitate mandibular advancement. In order to address palatal constriction, a known factor contributing to the development of obstructive sleep apnea (OSA), the implementation of fast palatal expansion can serve as an effective intervention. This technique involves extending the oropharyngeal space, leading to an augmented total nasal volume [17]. Numerous dental and oral appliances have been developed and evaluated, demonstrating promising outcomes in enhancing oxygen supply through the reduction of airway collapse incidents. These devices are designed to address abnormalities in the upper airway and ensure that the airway remains open by stabilizing the soft palate and expanding the size of the posterior oropharyngeal airway by protrusion of the mandible[18-24]. The primary aim of this bibliometric analysis was to assess the changing trends, contents and context related of Pediatric Sleep Apnea. The research question we explored were What were the Dental Trends, Contents and Context of Pediatric Obstructive Sleep Apnea?

METHODOLOGY

A systematic search strategy was formulated using synonyms of the Key words. The search strategy used for this bibliometric analysis was as follows.

Search Strategy

((ALL("Obstructive Sleep Apnea") OR ALL("Sleep disorder") OR ALL("Obstructive Sleep Apnea Syndrome") OR ALL("Obstructive Sleep Apnea Hypopnea Syndrome (OSAHS)") OR ALL("Sleep Apnea Syndrome") AND ALL("Pediatric Dentistry") OR ALL("Pedodontia") OR ALL("Child Dentistry") OR ALL("Pediatric Dental Care") OR ALL("Pediatric Dental Medicine") OR ALL("Pediatric Oral Health")) AND (LIMIT-TO (SUBJAREA,"DENT"))) The search strategy was applied on Scopus Database from which 930 articles were systematically searched and citation information, bibliometric information, abstract and keyword information, funding details and reference information was exported in CSV format. The data was analyzed by Two Authors and duplicates were removed by SJ and CB and if any discrepancy was observed in the article





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selection third author GP was contacted and the query was resolved by providing a mutual consensus. Total of 930 Documents were studied after duplicate removal. The data was further subjected to Visualization using VOS Viewer Version 1.6.19. Overlay Visualization of the data was plotted keeping threshold of minimum 2 documents with 2 citations. The data was subjected to Co-Authorship Analysis, Co-Occurrence of Keywords, Citation Analysis and Bibliographic Coupling.

RESULTS

In the present study a total of 930 Published Literature were included of which 701(75.37%) were Articles, 129 (13.87) were Review articles, 65 (6.98) were Book Chapters, 18 (1.93%) were Books related to OSA, 6(0.64%) were Letter, 4(0.44%) were Short Survey, 3 (0.33%) were conference papers, Editorials 2(0.22%) and 2(0.22%) were notes. (Table 1) These documents were published across various Geographic locations wherein it was observed that United States had 236 Published Documents followed by Brazil 164. India had published 58 Documents where maximum of them were from Saveetha Dental College and Hospital. (Figure1) The first Published literature pertaining to mentioning of the OSA in Pediatric Dentistry articles was observed in 1993 for the Literature published by Juambeltz et al (Nursing Caries and Lactose Intolerance). A linear increasing trend was observed in Publications of Documents pertaining to Obstructive Sleep Apnea where the highest Publication was observed for year 2021 and uptil now in 2023 103 publications pertaining to OSA have been published. (Figure 2) The analysis of the top publication sources revealed that American Journal of Orthodontics and Dentofacial Orthopedics had highest documents 55 published related to Obstructive Sleep Apnea. The European journal of Pediatric Dentistry had 32 published documents and Journal of Clinical and Pediatric Dentistry had 25 Publications. (Figure 3) The analysis of the Funding sponsors depicted that Coordenação de Aperfeiçoamento de Pessoal de Nível Superior had funded 46 research works. (Figure 4)

Co Authorship

Authors

A total of 908 Authors were identified who published literature related to OSA, It was observed that Iwasaki T, Saitoh I, Takemoto Y et al had obtained 102 citations for the 2 documents published. The overview visualization depicted that Cagna D.r, Donovan T.E et al had 4 citations for 2 recently published document. However, there was no links between the authors.(Table 2;Figure 5).

Organization

The co authorship analysis between organization depicted that Saveetha Dental College and Hospital India had published highest literature pertaining to OSA and Pediatric Dentistry which obtained 2 Citations whereas the Highest citation of 285 was obtained by Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Alta, Canada for 2 documents published. Whereas the highest link strength of 21 was observed for Department of Orofacial Pain and Dysfunction, Academic Centre for Dentistry, Amsterdam for 6 Documents which received 67 Citations. In the latest trend it was observed that Department of Comprehensive Oral Health University of North Carolina School of Dentistry had 14 links for 2 documents published in 2022 with 5 Citations. (Figure 6)

Countries

It was observed that maximum documents 236 was published by United States receiving 4467 citations with 204 total links among organizations. The overlay visualization depicted that Cambodia, United Arab Emirates, Ireland, Iraq had recent published documents with average 2021 year of publication. (Figure 7)

Co-Occurrence of Author Keywords

From the Co-occurrence analysis it was observed that the maximum occurring author keyword was Bruxism followed by Malocclusion followed by Obstructive Sleep Apnea. However, these terms were in widespread use across 2016-2018. The recent terminologies/keywords include Fractal Analysis, Digital Dentistry, Finite Element





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Analysis, Mandibular Advancement, Cephalometric Analysis, Functional Appliances, ADHD etc. These terms have been used meticulously in Articles specifying about Obstructive Sleep Apnea.(Figure 8)
Citations

Documents

The highest citation (576) was obtained by De Vos W; Casselman J; Swennen G.R.J (2009) for the article titled Conebeam computerized tomography (CBCT) imaging of the oral and maxillofacial region: A systematic review of the literature [25]. However, there was no link between any of the documents. A recent literature published by Colonna A et al in 2021 titled Temporal Relationship between Sleep-Time Masseter Muscle activity and apnea-hypopnea A pilot Study [26].(Figure 9)

Sources

American Journal of Orthodontics and Dentofacial Orthopedics had highest Documents published with 1593 Citations, however Journal of Oral Rehabilitation had highest citation of 2086 for 43 documents. There were no link strengths between the Sources. The overlay visualization trend depicted that Journal of International Dental and Medical Research had 9 documents published with avg publication year of 2020, Journal of Stomatology, The International Journal of Clinical Pediatric Dentistry had 5 Documents with average year of publication of 2021, Oral and Maxillofacial Surgery had published 5 Documents in 2022.(Figure 10)

Authors

Iwasaki T etal had obtained highest citation followed by Jena A.K et al (90 Citations), There were no link strengths among the authors. (Figure 11)

Bibliographic Coupling

Sources

The highest link strength was observed for American Journal of Orthodontics and Dentofacial Orthopedics (1428) followed by Journal of Oral Rehabilitation (1282) in 2022 the maximum publications and bibliographic coupling was observed for literature published by Frontiers in Oral Health with 22 links and 67 link strength and average year of publication of 2022. (Figure 12)

Organization

The overlay visualization depicted that Saveetha Dental College and Hospital had Highest bibliographic coupling whereas the recent trend depicted that Department of Dentistry Dental School IRCCS San Raffel Hospital had published literature related to OSA. (Figure 13)

Countries

The bibliographic coupling was highest for United states whereas in recent trend Iraq had 91 links for 2 documents with average year of publication of 2023 and United Arab Emirates had 2766 links for 9 documents published in average year of 2021.(Figure 14)

DISCUSSION

The publication titled "sleep disorders and Sleep Deprivation: An Unmet Public Health Problem" was released in 2006 by the "Institute of Medicine", which is now recognized as the "National Academy of Sciences". The primary findings of this influential paper shed light on a potential avenue for dentists to collaborate with the medical community in providing integrated treatment for paediatric patients with sleep-related respiratory issues. The report highlights the significant demand for the care of children with sleep-related breathing disorders, emphasizing the scarcity of healthcare professionals available to diagnose and treat these children. It suggests adopting an interdisciplinary approach that incorporates dentistry alongside various medical and healthcare disciplines.





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Concerning this these the landscape in the Diagnosis, Treatment and Prognosis has been depicted to show a greater rise and positive trend [27]. Our Bibliometric analysis which aimed to identify these key trends changes in Sleep Disordors (Obstructive Sleep Apnea) in Pediatric patients has showcased an improvement from Traditional Methods to usage of modern-day cutting-edge technology for diagnosis, treatment and prognosis of the Obstructive Sleep Apnea in pediatric age group. In the present study a total of 930 Published Literature were critically viewed for their bibliometric parameters It was observed that these documents were published across various Geographic locations wherein it was observed that United States had highest published documents. These are consistent with the bibliometrics performed by Pan L et al [28] wherein the authors remarked that United States has been leading in the global research field of OSA. A linear increasing trend was observed in Publications of Documents pertaining to Obstructive Sleep Apnea where the highest Publication was observed for year 2021 and uptil now in 2023 publications pertaining to OSA have been published. Which was also in consensus with the Pan L et al study [28] The analysis of the top publication sources revealed that American Journal of Orthodontics and Dentofacial Orthopedics had highest documents. The analysis of the Funding sponsors depicted that Coordenação de Aperfeiçoamento de Pessoal de Nível Superior had funded 46 research works.

The recent terminologies/keywords include by the authors have showcased Fractal Analysis, Digital Dentistry, Finite Element Analysis, Mandibular Advancement, Cephalometric Analysis, Functional Appliances. Hajipour F et al investigated This study investigates the potential alterations in spectral and higher order statistical characteristics of tracheal breathing sounds during the transition from waking to sleep, specifically in connection to obstructive sleep apnea (OSA). In addition to Kurtosis and Katz fractal dimension (KFD), three distinct frequency-based characteristics were computed from the power spectra of each normalized expiratory sound. These features were then compared both within and across the groups [29]. Another study performed by Cai H et al (2022) studied the flow characteristics of the upper airway in children diagnosed with obstructive sleep apnea-hypopnea syndrome by usage of Finite Element Analysis [30]. Yu M et al published a holistic Systematic Review on Orthodontic Appliances for Pediatric Sleep Apnea The authors included article which focused on RME: rapid maxillary expansion; AHI: apnea-hypopnea index; PSG: polysomnography; AT: adenotonsillectomy; MFT: myofunctional therapy; MAA: mandibular advancement appliance. The limitations of the study depict usage of single database. One of the Key strengths of our study is this analysis provides a key visualization of the findings related to Pediatric Sleep Apnea in Dental Domain. It provides a greater overview of the findings and results being obtained from a holistic software the Vos Viewer.

CONCLUSION

The Obstructive Sleep Apnea has portrayed significant changes in Trends Contents and Context over a time period and has depicted a significant progress by showcasing increased utilization of newer technologies, modification in diagnosis and increase in usage of Artificial Intelligence for Diagnosis and Management of Obstructive Sleep Apnea.

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Table 1: Categories of the published documents related to OSA

Sr.No	Document Type	Frequency	Percentage
1	Article	701	75.37
2	Review	129	13.87
3	Book Chapter	65	6.98
4	Book	18	1.93
5	Letter	6	0.64
6	Short Survey	4	0.44
7	Conference Paper	3	0.33
8	Editorial	2	0.22
9	Note	2	0.22
	Total	930	100%

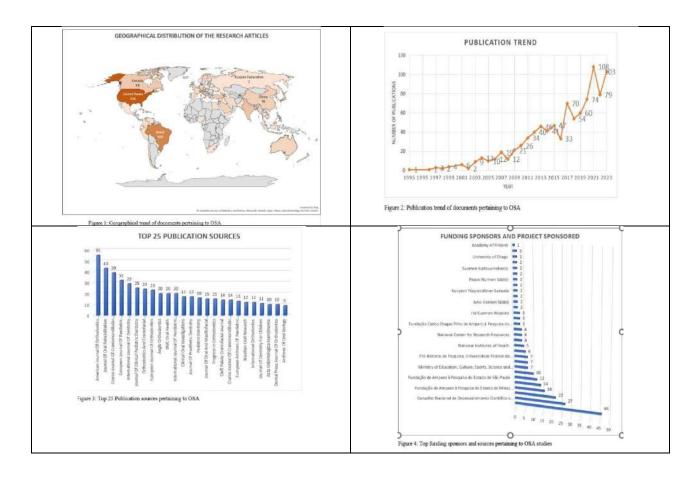
Table 2: Study documents with total, threshold and largest set of connected items.

	Total	Threshold	Largest Set of Connected Items
Co-Authorship			
Authors	908	23	
Organization	2612	143	20
Countries	83	52	51
Co-Occurrence Author Keywords	1518	368	367
Citation			



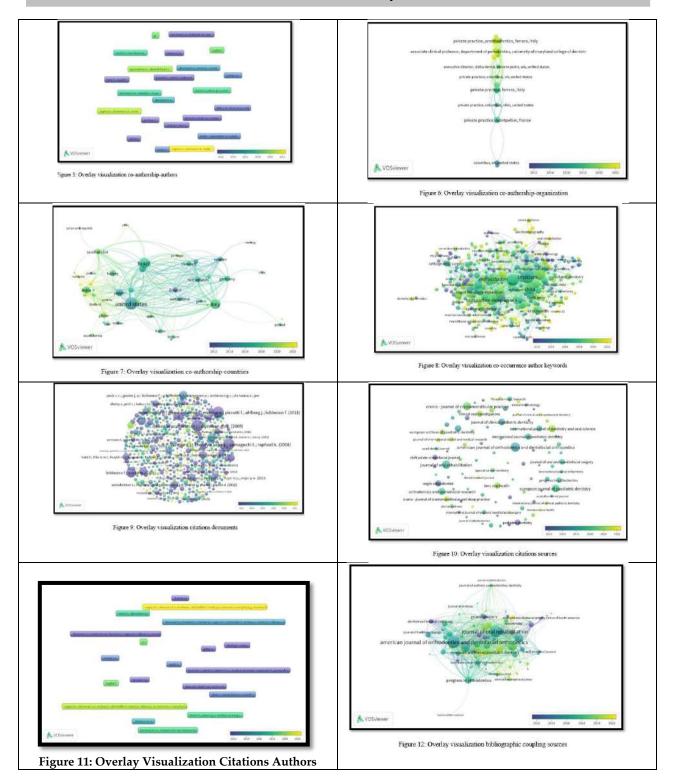


Documents	930	639	0
Sources	213	97	0
Authors	908	23	0
Organization	2612	143	0
Countries			
Bibliographic Coupling			
Documents	930	639	501
Sources	213	97	96
Authors	908	23	7
Organization	2612	143	20
Countries	83	52	51



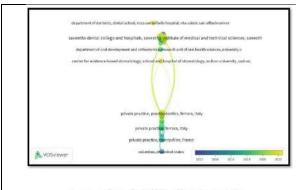












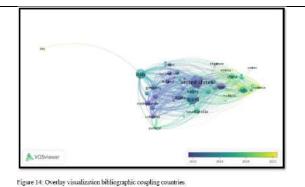


Figure 13: Overlay visualization bibliographic coupling organization





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REVIEW ARTICLE

Bio-Pharmacokinetics of Nicotine: A Brief Review

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ABSTRACT

Nicotine is natural tobacco alkaloids. In tobacco leaf it acts as botanical insecticide. In commercial cigarette tobacco nicotine level is about 1.5% by weight and comprising about 95% of the total alkaloid content. Nicotine creats tobacco addiction and influences tobacco use patterns. It is also used as a pharmacological aid for smoking cessation. Pharmacological study reveals that how nicotine addiction and smoking behavior influences smoking cessation therapy. After exposure of nicotine in human body its physiological absorption, distribution, metabolism and excretion are reviewed in this article. After exposure, it is absorbed and enters into the blood (pH 7.4), and divided into ionized (69%) and nonionized (31%) form. After absorption in blood, it has a binding capacity of less than 5% with plasma protein and then is distributed to tissues. Nicotine has the ability to cross the placental barrier. Various report stated that smoking habit during pregnancy accumulate the nicotine in fetal serum as well as its concentration in amniotic fluid is high than maternal serum. Several enzymes in liver like CYP2A6, UDPglucuronosyl transfease (UGT), and flavin-containing monooxygenase (FMO) are involved in metabolization of nicotine and metabolic end-products are excreted through kidney. This review article will highlight several physio-pharmacological aspects of nicotine.

Keywords: Nicotine, distribution, excretion, immunological cell

INTRODUCTION

Human physiological system is a God gifted, most powerful and sophisticated machinery in Earth. Achievement of healthy physiological system to an individual also improves the social quality. Use of tobacco either in smoke or smokeless tobacco (SLT) form is the frontline cause of death throughout the World but it can be preventable. Several





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carcinogenic chemicals are present in cigarettes, smokeless tobacco, chewing gum and other tobacco related products; but out of them nicotine is more lethal ingredients. Nicotine is considered as one of the most toxic poisons which acts on human neural pathways, gastrointestinal system, and excretory system as well as on immune system and affect their normal functions. World Health Organization (WHO) reported 50% of men, 8% of women are addicted to any form of tobacco in developing countries like Asia and Africa.

Chemical nature of nicotine

Nicotine, a natural liquid alkaloid with a molecular weight of 162.23 KD is generally an organic compound which is levorotatory free base and composed of carbon, hydrogen, Nitrogen, and occasionally oxygen. Nicotine was first identified in tobacco leaves (Gerald, 1981). The chemical structure of nicotine was first proposed by Jacobbon and Crosy. It was named as nicotine in respect of Jean Nicol who introduced tobacco in France in sixteenth century (Jacobson and Crosy, 1971). The chemical structure of nicotine is C₁₀H₁₄N₂ and according to nomenclature, nicotine is denoted as *3-(1-methyl-2-pyrrolidinyl)pyridine* (Pailer, 1964). Out of four possible configuration of nicotine, the most common is the rotation between conformations I and II which is based on dipole moment calculations of nicotine and nicotine-N-oxide in benzene solutions. Orthogonal position of pyridine ring to pyrrolidine makes the configuration more stable. In case of conformation I, the hydrogen on C3 of the pyrrolidine ring is behind H4 of the pyridine ring whereas in case of conformation II, the same in behind H2 (Fig. 1). By rotating the pyrrolidine ring the conversion between the two conformations are realized (Sheridan et al., 1986).

Nicotine and other alkaloids in variuos tobacco products

Nicotine is a tertiary amine. It is composed of pyridine and pyrrolidine ring (Fig. 1). Nicotine is mainly present in two separate three-dimensional structures known as stereoisomers. S-nicotine, also known as *l-nicotine* is the pharmacologically active form in tobacco. R-nicotine, also known as *d-nicotine* is found less in tobacco. Few racemization occurs during this combustion process (Pool et al., 1985). Nicotine is a plant product and it's concentration vary with different strains of tobacco depending on variation of parts and their growing to several geographical areas. So, manufacturerers do not mention the amount of nicotine in tobacco products such as cigarettes, SLTs etc. Higher stalk position of tobacco plants have higher concentration of nicotine as compared to normal; whereas the ribs and stems have very least concentration. Alteration of nicotine concentration in commercial tobacco is achieved by mixing different parts of different varieties of tobacco leaf to some extent (Table 1) (Rathkamp et al., 1973).

Absorption of nicotine

Nicotine, a weak base with a pKa of 8.0 (aqueous medium, 25°C) is pH dependently absorbed through biological membranes. It indicates that 50% of nicotine is ionized and 50% is non-ionized at pH 8.0 (Armitage and Turner, 1970; Schievelbein et al., 1973). In acidic environment i.e., at ionized state, nicotine does not rapidly cross the membrane. The p^H of tobacco smoke is important for determination of nicotine absorption from different sites within the body. When tobacco smoke is taken through oral route i.e., during cigarette smoking there is a little amount of buccal absorption of nicotine (Gori et al., 1986). The smoke of air-cured tobaccos, pipes, cigars, few European cigarettes is alkaline and increasing its pH from 6.5 to 7.5 or higher (Brunneman and Hoffmann, 1974). In alkaline environment i.e., at non-ionized state nicotine easily crosses the membranes. In alkaline pH, the nicotine of tobacco smoke is well absorbed through the mouth (Armitage et al., 1978; Russell et al., 1980). Firstly due to large surface area of small airways and alveoli of the lung and secondly due to dissolution of nicotine at physiological pH (closely 7.4), it easily transfer cell membranes and absorbed rapidly there during tobacco smoke which increases the nicotine concentration in blood very fast (Armitage et al., 1975). Chewing of tobacco, snuff, and any type of SLT are of alkaline pH. Manufacturers use additives during such type of tobacco selection. Nicotine is absorbed across mucous membrane in alkaline environment. Absorption rate of nicotine from SLT depends on the nature of product and the route of administration. Nicotine level in blood hike very fast like cigarette smoking due to nasal snuff (Russell et al., 1981). Oral snuff and any kind of chewing form of tobacco are absorbed in human physiological system gradually. Due to larger surface area and alkaline environment nicotine is quickly absorbed in small intestine in compare with stomach because the environment in stomach is acidic due to secretion of gastric hydrochloric acid (Jenner et al., 1973; Travell,





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1960). Bioavailability of swallowed nicotine from the gastrointestinal tract is incomplete due to presystemic metabolism. After absorption into the portal venous circulation, nicotine is metabolized by liver before it reaches to the systemic venous circulation. Skin contact of nicotine containing pesticides is poisoning as nicotine is absorbed through skin (Benowitz et al., 1987; Faulkner 1933). Cutaneous absorption of nicotine and its toxicity in tobacco filed worker has been reported early (Gehlbach et al., 1975).

Distribution of nicotine

After absorption in blood, less than 5% of nicotine binds to plasma protein and distributed exclusively to the body tissues with a fixed distribution volume of 180 liters (Table 2). Nicotine value is 2.6 times higher than the predicted amount as evidenced by the blood product concentration and body weight when it is completely equilibrated. Nicotine uptake in spleen, liver, lungs and brain is high compared to adipose tissue in experimentally nicotine infused rabbit (Table 3) (Benowitz et al., 1982). After intravenous (i.v.) injection, the concentration of nicotine is quickly declines due to tissue uptake but sometimes later its concentration gradually increases in arterial blood, lung and brain as compared to muscle and adipose tissues. This physiological consequence occurs due to rapid uptake of nicotine in brain (generally 1-2 min) and blood level falls due to peripheral tissue uptake (20-30 min) after nicotine administration. Nicotine uptake in animal brain has been studied by several researchers. High degree of nicotine uptake from blood to rat brain has been reported (Oldendorf, 1974). A radiographic study showed that i.v injection of nicotine increases the nicotine level in mice brain after 5 min which was cleared from the brain by 30 min (Schmiterlow et al., 1967). Stalhandske reported that i.v injection of 14C-nicotine is quickly taken up in mice brain and maximum accumulation was observed within 1 min of injection (Stalhandske, 1970).

Same finding was reported in monkeys after injection of ¹¹C-nicotine (Maziere et al., 1976). During tobacco smoking nicotine is inhaled and enters into blood through pulmonary circulation. The rate of entry of nicotine is similar to the rapid i.v injection. Due to entry into the lung, blood nicotine level is higher and lag time between smoking and nicotine entry into brain is comparatively shorter than i.v injection. The action of nicotine on brain occurs quickly after smoking. A puff of tobacco snap is believed to provide optimal re-enforcement for the development of drug dependence. After distribution to different tissues, the effect of nicotine declines. The distribution half-life, distribution kinetics and elimination kinetics determine the time course for action of central nervous system (CNS) to nicotine after a cigarette somke (Feyerabend et al., 1985). Nicotine present in SLT is mixed with saliva and directed toward stomach where it is trapped in the acidic environment of gastric juice and is reabsorbed from the small bowel for enteric nicotine re-circulation which ultimately reduces the nicotine level in blood (Russell and Feyerabend 1978; Russell, 1976). Nicotine has the ability to cross the placenta easily. It has been reported that smoking during pregnancy rises the nicotine level not only in amniotic fluid and breast milk but also in umbilical cord blood of neonates (Luck et al., 1982; Hibberd et al., 1978; Van Vunakis et al., 1974). In case of non-lactating smoker, nicotine is found in breast fluid (Hill and Wynder, 1979; Petrakis et al., 1978) and also in cervical mucous secretion (Sasson et al., 1985). Existance of nicotine is also traced in the freshly shampooed hair of not only smokers but also nonsmokers, due to environmental exposure to tobacco smoke (Haley and Hoffmann, 1985).

Metabolism of nicotine

Nicotine is not only metabolized in liver but also in lung to a small extent (Turner et al., 1975). Depending upon urinary p^H and urine flow, 35% of unutilized nicotine is excreted through renal system that accounts 5-10% of total elimination (Benowitz et al., 1983; Rosenberg et al., 1980). Cotinine and nicotine-N'-oxide are major metabolites of nicotine. Cotinine is formed in liver by two steps. Firstly, cytochrome P-450-mediated oxidation of position-5 pyrrolidine ring to nicotine-D^{1/(5)}-iminium ion (Peterson et al., 1987); secondly, the iminium ion is metabolized to cotinine by cytoplasmic *aldehyde oxidase* (Hibberd et al., 1978). Cotinine itself is metabolized and 17% excreted through urine (Benowitz et al., 1983). Cotinine has several metabolites like *trans*-3'-hydroxycotinine (McKennis et al., 1963), 5'-hydroxycotinine (Bowman and McKennis, 1962), cotinine-N-oxide, and cotinine methonium ion (McKennis et al., 1963). Among these *Trans*-3'-hydroxycotinine is the major metabolite (Neurath et al., 1987). Oxidative degradation of the pyrrolidine ring hikes 3-pyridylacetic acid (McKennis et al., 1964).





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Nicotine-I'-N-oxide is a minor metabolite of nicotine. Oxidation of nitrogen atom of the pyrrolidine ring depends on a microsomal flavoprotein system and produces two diasterisomers, 1'-(R)-2'-(S)cis- and 1'-(S)2'-(S)-trans- nicotine-I'-N'-oxide (Booth and Boyland 1970). After i.v. injection of nicotine, 100% of nicotine-N'-oxide is excreted through (Beckett et al., 1971a); whereas in case of oral administration only 30% is excreted and rest 70% is re-absorbed and takes part in further metabolism. Rectal administration of nicotine-N'-oxide in experimental animal recovers the same in urine lower than 10% (Beckett et al., 1970). *In vitro* and *in vivo* studies reported that nicotine- N'-oxide is converted to nicotine (Dajani et al., 1975). Blood nicotine and cotinine level have been measured in experimental rats after administration of nicotine-N,N'-dioxide and nicotine- N'-oxide (Sepkovic et al., 1986). Conversion of nicotine to its metabolites has not been well established till now. Study reveals that after 24 hr of i.v. nicotine injection, less than 10% of nicotine is excreted as cotinine in nonsmokers compared with an average of 25% in smokers (Beckett et al., 1971b). Study also reveals that cotinine is excreted through urine after 24 hr of smoking (Schievelbein, 1982). Cotinine has a half-life of 18-20 hr in smoker which means in 24 hr almost half of the cotinine is recovered. Urine collection after 72 hr of smoking cessassion is necessary to recover more than 90% cotinine (Benowitz et al., 1983).

Excretion of nicotine

As blood passes through kidney tubules; nicotine and its metabolites are diffused into urine for excretion (Ashton and stepney, 1982). Urinary excretion rate is p^H dependent (Beckett et al., 1972). In acidic urine, where nicotine is mostly in ionized form and tubular reabsorption is low; the clearance of nicotine may be as high as 600 mL/min (Benowitz et al., 1983; Rosenberg et al., 1980). In alkaline urine, a larger amount of nicotine remains in non-ionized form. Tubular reabsorption of non-ionized nicotine decreases the excretion rate and reduces the renal clearances as low as 17 mL/min. Renal clearance is about 100mL/min when urine pH is uncontrolled (Russell and Feyerabend, 1978).

Nicotine induced Oxidative stress in cellular system

Nicotine is a potent oxidant. It is the most biologically active ingredient present in tobacco smoke. It was reported that administration of nicotine causes the imbalance of prooxidant/antioxidant status in liver, kidney, heart, lung and spleen in male Wister rat (Neogy et al., 2008). It was also reported that *in vitro* nicotine treatment certainly damages the DNA and causes the imbalance of prooxidant/antioxidant status in lymphocytes (Das et al., 2009). *In vitro* nicotine treatment also dose dependently produces superoxide radical and damages lipid, protein and decreases the antioxidant enzyme status in murine peritoneal macrophages (Kar Mahapatra et al., 2009).

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Declaration of Interest

The author reports no conflicts of interest. The author alone is responsible for the content and writing of the paper.

Abbreviations

CNS : Central Nervous System
CYP2A6 : Cytochrome P450 2A6
DNA : Deoxyribonuclic acid

FMO : Flavin-containing monooxygenase

i.v. : Intravenous SLT : Smokeless tobacco

UGT : UDP-glucuronosyltransfeaseWHO : World Health Organization





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Table 1: Nicotine content in various tobacco products.

PRODUCTS	NICOTINE PRESENT (mg)
Cigarettes	168 mg/20 cigs
Chewing Tobacco	1,176 mg/70gm
Moist snuff	157 mg/15gm

Table 2: Human pharmacokinetics of nicotine and cotinine (Source: Average values based on data from Benowitz et al, 1982; Benowitz and Kuyt et al, 1983).

	NICOTINE	COTININE		
Half-life	120min	18hrs		
Volume of distribution	180L	88L		
Total clearance	1300ml/min	72ml/min		
Renal clearance	200ml/min (acid urine)	12ml/min		
Normal clearance	1100ml/min	60ml/min		

Table 3: Steady state distribution of nicotine.

	TISSUE TO BLOOD RATIO
Blood	1.0
Brain	3.0
Heart	3.7
Muscle	2.0
Adipose	0.5
Kidney	21.6
Liver	3.7





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Lung	2.0
Gastrointestinal	35

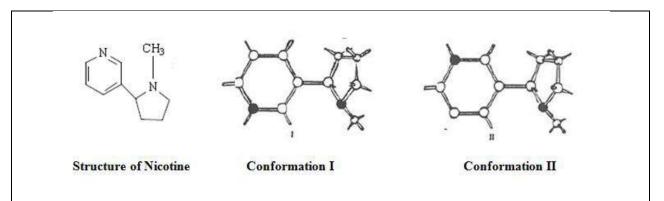


Fig.1: The structure and the two conformations of nicotine. Nitrogen is indicated by filled circle and carbon is represented by open circle. Hydrogen atoms are not indicated.





RESEARCH ARTICLE

Application of Borda Ranking Method based on Pentapartitioned **Neutrosophic Sets**

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ABSTRACT

This paper deals with the act of the Borda Count Method on the Five Symbol Valued Neutrosophic Logic named Pentapartitioned Neutrosophic Sets. The Core of this research article is to merge the uncertainty of the crisp set with the counting sense. Further, some examples are given to understand the proposed method of Borda Counting on Pentapartitioned Neutrosophic Set with and without using weights.

Keywords: Pentapartitioned Neutrosophic Borda Method, Ranking Method, Borda Count, Pentapartitioned Neutrosophic Set, Voting Theory on Pentapartitioned Neutrosophic Sets.

INTRODUCTION

The Borda Ranking Method is a voting framework intended to rank up-and-comers or choices in light of the inclinations of electors. It's named after Jean-Charles de Borda, a French mathematician and political expert who introduced it in the eighteenth century. The Borda Ranking Method is many times utilized in different settings, including elections for public workplaces, dynamic cycles inside associations, or even in sports competitions to rank groups. Because it considers the entire range of preferences expressed by voters rather than just the most popular choice, it is regarded as a method that is more equitable than some other voting systems. In 2005 Florintin Marandache[5] was first presented the Neutrosophic logic utilizing Zadeh's [8] Fuzzy set theory (1965) and Atanassov's [1] Intuitionistic set theory (1983). Later the concept of Pentapartitioned Neutrosophic Sets was first





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grounded by Rama Mallick [4] and Surapati Pramanik in 2020. They fostered the symbol value logic to five unique participation esteems in particular, truth, truth, contradiction, ignorance, unknown and lie.

MATERIALS AND METHODS

Definition.[4]A Pentapartitioned Neutrosophic Set (briefly PN set) M over non-empty universal set X is represented by, $M = \{(x, T_M(x), C_M(x), G_M(x), U_M(x), F_M(x) : x \in X)\}$ such that $0 \le T_M(x) + C_M(x) + G_M(x) + U_M(x) + F_M(x) \le S$ where $T_M(x)$, $C_M(x)$, $G_M(x)$, $G_M(x)$, $G_M(x)$, $G_M(x)$, $G_M(x)$, $G_M(x)$ represents the Truth Membership function, Contradiction Membership function, Ignorance Membership function, Unknown Membership function and False Membership function respectively.

Definition.[4] Let *A*, *B* be two Pentapartitioned Neutrosophic sets over *X*.

```
A \subseteq B if and only if T_A(x) \leq T_B(x), C_A(x) \leq C_B(x), G_A(x) \geq G_B(x), U_A(x) \geq U_B(x), F_A(x) \geq F_B(x) for each x \in X.

A \cup B = \{(x, max\ (T_A(x), T_B(x)), max\ (C_A(x), C_B(x)), min\ (G_A(x), G_B(x)), min\ (U_A(x), U_B(x)), min\ (F_A(x), F_B(x)))/x \in X\}.

A \cap B = \{(x, min\ T_A(x), T_B(x)), min\ T_A(x), T_B(x)), min\ T_A(x), T_B(x))/x \in X\}.

If A = \{(x, T_A(x), U_B(x)), max\ (F_A(x), F_B(x))/x \in X\}, then A^C = \{(x, F_A(x), U_A(x), 1 - (G_A(x)), C_A(x), T_A(x))/x \in X\}.

A \nsubseteq B if at aleast one of the following occurs T_A(x) \geq T_B(x), C_A(x) \geq C_B(x), G_A(x) \leq G_B(x), U_A(x) \leq U_B(x), F_A(x) \leq F_B(x) for any x \in X.

A \neq B if A \nsubseteq B and B \nsubseteq A.
```

Definition.[4] A Pentapartitioned Neutrosophic set over X is said to be null Pentapartitioned Neutrosophic set if, $T_A(a) = 0$, $C_A(a) = 0$, $C_A(a) = 1$, $U_A(a) = 1$, $U_A(a) = 1$. We denote the null Pentapartitioned Neutrosophic set by 0_{PN} . That is $0_{PN} = \{(a, 0, 0, 1, 1, 1)/a \in X\}$.

Definition.[4] A Pentapartitioned Neutrosophic set over X is said to be absolute Pentapartitioned Neutrosophic set if, $T_A(a) = 1$, $C_A(a) = 1$, $C_A(a) = 0$, $C_A(a) = 0$, $C_A(a) = 0$. We denote the absolute Pentapartitioned Neutrosophic set by $C_A(a) = 0$. That is $C_A(a) = 0$, $C_A(a) = 0$, $C_A(a) = 0$. We denote the absolute Pentapartitioned Neutrosophic set by $C_A(a) = 0$, C

RESULTS AND DISCUSSION

Borda Algorithm on PN Sets

Consider $a_1, a_2, a_3, ..., a_m$ be m different events, and $e_1, e_2, e_3, ..., e_n$ be n different criterias of occurance for those events. We can classify criteria into two values. One is Favor and the other is Loss. For example if the criteria is about a benifitial thing for our event then that criteria is treated as a Favor Criteria. Suppose acriteria is not a profitable thing for our event then that is treated as a Loss Criteria. The following tabulation pictures the action of criteria on the corresponding events.

Representation of criteria and corresponding events

Criteria\Events	a_1	a_2	•••	a_m
e_1	a ₁₁	a_{21}		a_{m1}
e_2	a ₁₂	a ₂₂		a_{m2}
e_n	a_{1n}	a_{2n}		a_{mn}





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Now for every $p \in \{1, 2, ..., m\}$ and $q \in \{1, 2, ..., n\}$, the representation $(a_p, T_{e_p}(a_p), C_{e_p}(a_p), G_{e_p}(a_p), U_{e_p}(a_p), F_{e_p}(a_p))$ represents the truth, contradiction, ignorance, unknown and false membership values of the event a_p under the criteria e_p . Also, it satisfies the condition $0 \le T_{e_p}(a_p) + C_{e_p}(a_p) + C_{e_p}(a_p) + U_{e_p}(a_p) + V_{e_p}(a_p) + V_{e_p}(a_p) \le 5$.

The ranking of events is calculated either with or without the weights of the criteria. The algorithm for both methods are as follows:

Without weight

This is an elementary approach of calculating the rank without using the weights of the criteria.

- a. Suppose e_q where $q \in \{1, 2, ..., n\}$ be a Favor Criteria
- 1. Put all the Truth Membership Function $T_{e_p}(a_p)$ for $p \in \{1, 2, ..., m\}$ in Descending Manner. And give rank to them starting with 1.
- 2. Put all the Contradiction Membership Function $C_{e_p}(a_p)$ for $p \in \{1, 2, ..., m\}$ in Descending Manner. And give rank to them starting with 1.
- 3. Put all the Ignorance Membership Function $G_{e_p}(a_p)$ for $p \in \{1, 2, ..., m\}$ in Ascending Manner. And give rank to them starting with 1.
- 4. Put all the Unknown Membership Function $U_{e_p}(a_p)$ for $p \in \{1, 2, ..., m\}$ in Ascending Manner. And give rank to them starting with 1.
- 5. Put all the False Membership Function $F_{e_p}(a_p)$ for $p \in \{1, 2, ..., m\}$ in Ascending Manner. And give rank to them starting with 1.
- b. Suppose e_q where $q \in \{1, 2, ..., n\}$ be a Loss Criteria
- 1. Put all the Truth Membership Function $T_{e_p}(a_p)$ for $p \in \{1, 2, ..., m\}$ in Ascending Manner. And give rank to them starting with 1.
- 2. Put all the Contradiction Membership Function $C_{e_p}(\alpha_p)$ for $p \in \{1, 2, ..., m\}$ in Ascending Manner. And give rank to them starting with 1.
- 3. Put all the Ignorance Membership Function $G_{e_p}(a_p)$ for $p \in \{1, 2, ..., m\}$ in Descending Manner. And give rank to them starting with 1.
- 4. Put all the Unknown Membership Function $U_{e_p}(a_p)$ for $p \in \{1, 2, ..., m\}$ in Descending Manner. And give rank to them starting with 1.
- 5. Put all the False Membership Function $F_{e_p}(a_p)$ for $p \in \{1, 2, ..., m\}$ in Descending Manner. And give rank to them starting with 1.

The rank that is given for the truth membership function for the event a_p under the criteria e_q is called the Borda Truth Sub-Rank of a_{pq} . In the similar aspect we can define the Borda Contradiction Sub-Rank, Borda Ignorance Sub-Rank, Borda Unknown Sub-Rank, and Borda False Sub-Rank of a_{pq} . Also, they are denoted by $SR_T(a_{pq}), SR_C(a_{pq}), SR_G(a_{pq}), SR_U(a_{pq})$, and $SR_F(a_{pq})$ respectively. Then the Borda Rank of a_{pq} for each event a_p with everydistinctcriteria e_q where $p \in \{1, 2, ..., m\}$ and $q \in \{1, 2, ..., n\}$ is calculated using the formula $BR(a_{pq}) = SR_T(a_{pq}) + SR_C(a_{pq}) + SR_G(a_{pq}) + SR_U(a_{pq}) + SR_F(a_{pq})$. The Borda Number for the event a_p where $p \in \{1, 2, 3, ..., m\}$ is defined by summing up all the difference of Borda Ranks corresponding to each criteria e_q where $q \in \{1, 2, 3, ..., n\}$ from 5m. And is denoted by $BN(a_p)$.

$$BN(a_p) = \sum_{q=1}^{n} (5m - BR(a_{pq})) - - - (A)$$

The value 5*m* is taken from the total number of logics acted in the PN set. That is there is a '*m*' for a logic.

To obtain the Optimum Event, arrange the Borda Number in the Descending Manner. That sequence of numbers represents the sequence of best events in Descending Motion.





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With weight

Solving the MCDM problem with individual weights for each criteria can yield a better solution than solving the MCDM problem without weights. In this section we defined how to calculated the Borda Number of the event a_p where $p \in \{1, 2, 3, ..., m\}$ under the criteria e_q where $q \in \{1, 2, 3, ..., n\}$ with weights.

The weights of each criteria e_q where $q \in \{1, 2, 3, ..., n\}$ is calculated by the following steps:

- a. Find the mean (AM) for the Truth membership functions using $\bar{x}_q(T) = \frac{1}{m} \sum_{p=1}^m (T(a_{pq}))$
- b. Find the mean deviation of Truth membership functions using $\sigma_q(T) = \frac{1}{m} \sum_{p=1}^m \left(T(a_{pq}) \bar{x}_q(T) \right)$
- c. Calculate the Coefficient of Variation for Truth membership function using $CV_q(T) = \frac{\sigma_q(T)}{\bar{x}_q(T)}$ In a similar manner we can find the Coefficient of Variation for Contradiction, Ignorance, Unknown and False membership functions and denoted by $CV_q(C)$, $CV_q(G)$, $CV_q(U)$, and $CV_q(F)$ respectively.
- d. Find Weight of Truth Membership Function using $w_q(T) = \frac{cV_q(T)}{\sum_{x=1}^n (cV_x(T))}$ In a similar manner we can find the Weights for Contradiction, Ignorance, Unknown and False membership functions and denoted by $w_q(C)$, $w_q(G)$, $w_q(G)$, $w_q(U)$, and $w_q(F)$ respectively.
- e. Finally find the Weight of the Criteria e_q where $q \in \{1, 2, 3, ..., n\}$ is calculated by

$$W_{e_q} = \frac{w_q(T) + w_q(C) + w_q(G) + w_q(U) + w_q(F)}{5}$$

The of the criteria has the condition $W_{e_q} \ge 0$ for all q = 1, 2, 3, ..., n

Using weights of the individual criteria the Borda Number is calculated by the following formula:

$$BN(a_p) = \sum_{q=1}^{n} W_{e_q}(5m - BR(a_{pq})) - - - (\mathbf{B})$$

If we assume all the weight of the individual criteria equal to 1, then it act as the system of unweighted.

Illustrative Example

Consider the events as the bike brands and fuel efficiency, engine refinement, vibration during ride as the criteria. In this example fuel efficiency and engine refinement are Favor Criteria and Vibration during ride is Loss Criteria. The values of opinion are tabulated in the following table:

Values of Opinion

Events\ Criteria	e₁= Fuel efficiency	e_2 = Engine refinement	e_3 =Vibration During Ride
Bike 1	(0.7, 0.6, 0.2, 0.7,0.6)	(0.6, 0.4, 0.8, 0.3,0.5)	(0.8, 0.5, 0.66, 0.42,0.36)
Bike 2	(0.63, 0.78, 0.58, 0.4,0.74)	(0.54, 0.24, 0.81, 0.66, 0.46)	(0.46, 0.63, 0.94, 0.43, 0.35)
Bike 3	(0.28, 0.28, 0.07, 0.99, 0.62)	(0.3, 0.55, 0.03, 0.75,0.73)	(0.17, 0.42, 0.36, 0.74,0.88)





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Bike 4	(0.05, 0.68, 0.42, 0.9,0.88)	(0.12, 0.75, 0.4, 0.95,0.79)	(0.55, 0.84, 0.86, 0.46,0.62)
Bike 5	(0.44, 0.65, 0.72, 0.54,0.78)	(0.98, 0.39, 0.36, 0.94,0.85)	(0.42, 0.29, 0.46, 0.53,0.3)

The following steps very clearly explains the methodology of finding Borda Number.

Step 1: Consider the criteria e_1

a.
$$T_{e_1}(a_1) > T_{e_1}(a_2) > T_{e_1}(a_5) > T_{e_1}(a_3) > T_{e_1}(a_4)$$
.
 $SR_T(a_{11}) = 1$; $SR_T(a_{21}) = 2$; $SR_T(a_{51}) = 3$; $SR_T(a_{31}) = 4$; $SR_T(a_{41}) = 5$.

b.
$$C_{e_1}(a_2) > C_{e_1}(a_4) > C_{e_1}(a_5) > C_{e_1}(a_1) > C_{e_1}(a_3)$$

 $SR_{\mathcal{C}}(a_{21}) = 1; SR_{\mathcal{C}}(a_{41}) = 2; SR_{\mathcal{C}}(a_{51}) = 3; SR_{\mathcal{C}}(a_{11}) = 4; SR_{\mathcal{C}}(a_{31}) = 5.$

c.
$$G_{e_1}(a_3) < G_{e_1}(a_1) < G_{e_1}(a_4) < G_{e_1}(a_2) < G_{e_1}(a_5)$$

 $SR_G(a_{31}) = 1$; $SR_G(a_{11}) = 2$; $SR_G(a_{41}) = 3$; $SR_G(a_{21}) = 4$; $SR_G(a_{51}) = 5$.

d.
$$U_{e_1}(a_2) < U_{e_1}(a_5) < U_{e_1}(a_1) < U_{e_1}(a_4) < U_{e_1}(a_3)$$

 $SR_U(a_{21}) = 1$; $SR_U(a_{51}) = 2$; $SR_U(a_{11}) = 3$; $SR_U(a_{41}) = 4$; $SR_U(a_{31}) = 5$.

e.
$$F_{e_1}(a_1) < F_{e_1}(a_3) < F_{e_1}(a_2) < F_{e_1}(a_5) < F_{e_1}(a_4)$$

 $SR_F(a_{11}) = 1$; $SR_F(a_{31}) = 2$; $SR_F(a_{21}) = 3$; $SR_F(a_{51}) = 4$; $SR_F(a_{41}) = 5$.

Now
$$BR(a_{11}) = SR_T(a_{11}) + SR_C(a_{11}) + SR_G(a_{11}) + SR_U(a_{11}) + SR_F(a_{11}) = 11$$

Similarly, $BR(a_{21}) = 11$, $BR(a_{31}) = 17$, $BR(a_{41}) = 19$, $BR(a_{51}) = 17$,

Step 2: Consider the criteria e_2 proceed like step1

We can get the Borda Ranks of the events as

$$BR(a_{12}) = 12$$
, $BR(a_{22}) = 16$, $BR(a_{32}) = 13$, $BR(a_{42}) = 18$, $BR(a_{52}) = 16$,

Step 3: Consider the criteria e_3 proceed like step1

We can get the Borda Ranks of the events as

$$BR(a_{13}) = 19$$
, $BR(a_{23}) = 16$, $BR(a_{33}) = 10$, $BR(a_{43}) = 16$, $BR(a_{53}) = 14$,

Step 4: Find Borda Number using (A)

$$BN(a_1) = (25 - 11) + (25 - 12) + (25 - 19) = 33$$

 $BN(a_2) = (25 - 11) + (25 - 16) + (25 - 16) = 32$
 $BN(a_3) = (25 - 17) + (25 - 13) + (25 - 10) = 35$
 $BN(a_4) = (25 - 19) + (25 - 18) + (25 - 16) = 22$
 $BN(a_5) = (25 - 17) + (25 - 16) + (25 - 14) = 28$

Step 5: Arrange all Borda number in Descending Manner to get optimum bike brand.

$$BN(a_3) > BN(a_1) > BN(a_2) > BN(a_5) > BN(a_4).$$

Hence the result is among all the Bike Brand 3 is best when considering all the criteria and the Bike Brand 4 is worst when considering all the criteria.

Next using the same example with weight we can check the solution.

Step i: Consider the criteria e_1

- a. First find the AM of the Truth membership values $\bar{x}_1(T) = \frac{0.7 + 0.63 + 0.28 + 0.02 + 0.44}{5} = 0.42$
- b. Find the Mean deviation $\sigma_1(T) = 0.204$
- c. Then find Coefficient of Variation using $CV_1(T) = \frac{\sigma_1(T)}{\bar{x}_1(T)} = \frac{0.204}{0.42} \approx 0.48571$
- d. Find the AM of the Contradiction membership values $\bar{x}_1(C) = \frac{0.6 + 0.78 + 0.28 + 0.68 + 0.65}{5} = 0.598$
- e. Find the Mean deviation $\sigma_1(C) = 0.1272$





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Then find Coefficient of Variation using $CV_1(C) = \frac{\sigma_1(C)}{\bar{x}_1(C)} = \frac{0.1272}{0.598} \approx 0.21271$ f.

Find the AM of the Ignorance membership values $\bar{x}_1(G) = \frac{0.2+0.58+0.07+0.42+0.72}{r} = 0.398$ g.

Find the Mean deviation $\sigma_1(G) = 0.2104$ h.

Then find Coefficient of Variation using $CV_1(G) = \frac{\sigma_1(G)}{\bar{x_1}(G)} = \frac{0.2104}{0.398} \approx 0.52864$ i.

Find the AM of the Unknown membership values $\bar{x}_1(U) = \frac{0.77 + 0.4 + 0.99 + 0.94}{r} = 0.706$ j.

Find the Mean deviation $\sigma_1(U) = 0.1912$ k.

1.

Then find Coefficient of Variation using $CV_1(U) = \frac{\sigma_1(U)}{\bar{x}_1(U)} = \frac{0.1912}{0.706} \approx 0.27082$ Find the AM of the Truth membership values $\bar{x}_1(F) = \frac{0.6+0.74+0.62+0.88+0.78}{5} = 0.724$ m.

Find the Mean deviation $\sigma_1(F) = 0.0912$ n.

Then find Coefficient of Variation using $CV_1(F) = \frac{\sigma_1(F)}{\bar{x}_1(F)} = \frac{0.0912}{0.724} \approx 0.12597$. o.

Step ii: Consider the criteria e_2

Proceeding like Step i, we can get, $CV_2(T) \approx 0.4693$; $CV_2(C) \approx 0.3159$; $CV_2(G) \approx 0.5417$; $CV_2(U) \approx 0.2667$; $CV_2(F)$ 0.2234.

Step iii: Consider the criteria e_3

Proceeding like Step i, we can get, $CV_3(T) \approx 0.325$; $CV_3(C) \approx 0.2970$; $CV_3(G) \approx 0.03$; $CV_3(U) \approx 0.1845$; $CV_3(F) \approx 0.03$ 0.3952.

Step iv: Calculate the weight of all the Membership Function for criteria e_1

$$w_1(T) = \frac{CV_1(T)}{\sum_{x=1}^{n}(CV_x(T))} = \frac{0.4857}{0.4857 + 0.4693 + 0.325} = 0.3795$$

$$w_1(C) = \frac{CV_1(C)}{\sum_{x=1}^{n}(CV_x(C))} = \frac{0.2127}{0.2127 + 0.3159 + 0.2970} = 0.2576$$

$$w_1(G) = \frac{CV_1(G)}{\sum_{x=1}^{n}(CV_x(G))} = \frac{0.5286}{0.5286 + 0.5417 + 0.0.3} = 0.3858$$

$$w_1(U) = \frac{CV_1(U)}{\sum_{x=1}^{n}(CV_x(U))} = \frac{0.2708}{0.2708 + 0.2667 + 0.1845} = 0.3751$$

$$w_1(F) = \frac{CV_1(F)}{\sum_{x=1}^{n}(CV_x(F))} = \frac{0.1259}{0.1259 + 0.2234 + 0.3952} = 0.1692$$

Proceeding the same for criteria e_2 and e_3

Step v: The weight for the criteria e_1 =

$$W_{e_1} = \frac{w_1(T) + w_1(C) + w_1(G) + w_1(U) + w_1(F)}{5}$$

$$= \frac{0.3795 + 0.2576 + 0.3858 + 0.3751 + 0.1692}{5} = 0.3134$$

Similarly, we can get $W_{e_2} = 0.3628$ and $W_{e_3} = 0.3239$

Step vi: Again using step1 to step3 of unweighted calculation and using (B) we can get the Borda Number.

$$BN(a_1) = 0.3134(25 - 11) + 0.3628(25 - 12) + 0.3239(25 - 19) = 11.047$$

$$BN(a_2) = 0.3134(25 - 11) + 0.3628(25 - 16) + 0.3239(25 - 16) = 10.5672$$

$$BN(a_3) = 0.3134(25 - 17) + 0.3628(25 - 13) + 0.3239(25 - 10) = 11.7176$$

$$BN(a_4) = 0.3134(25 - 19) + 0.3628(25 - 18) + 0.3239(25 - 16) = 7.3341$$

 $BN(a_5) = 0.3134(25 - 17) + 0.3628(25 - 16) + 0.3239(25 - 14) = 9.3341$

Step vii: Arrange all Borda number in Descending Manner to get optimum bike brand. $BN(a_3) > BN(a_1) > BN(a_2) > BN(a_5) > BN(a_4).$





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Hence in Weighted case also the result is among all the Bike Brand 3 is best when considering all the criteria and the Bike Brand 4 is worst when considering all the criteria.

CONCLUSION

In this paper we produced and investigated the algorithm of Borda Number for MCDM problems on Pentapartitioned Neutrosophic Sets. The analyse using the examples give a detailed view on the Borda numbers on both weighted and unweighted systems. This type of fixing the solution for MCDM problem can extend a lot in Voting Theory, and this will become the base our future research works.

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RESEARCH ARTICLE

Revolutionizing Pharmaceutical Manufacturing: Advancements Liquisolid System and their Diverse Applications

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ABSTRACT

Production of solid dosage forms with a lot of liquid requires innovative Liquisolid Systems and a good environment. They entail distributing the medication in a suitably hydrophilic, non-volatile, liquid drug or vehicle. To provide adequate flowability and suitable compression characteristics, this approach depends on extremely porous excipients mixed in the right proportions so they may either absorb or adsorb the liquid medicine. Liquisolid systems have shown promise in improving the bioavailability and rate of pharmaceutical dissolution for poorly soluble drugs, providing a less complicated and less expensive alternative to sophisticated and expensive methods. The production of oral disintegrating tablets, modified release tablets, and granular dosage forms combining herbal extracts in liquid, among other applications, have all been examined in recent study. The benefits of the most recent technologies are numerous, including their elegance, economic efficiency, environmental appropriateness, and largescale manufacturing. However, there are drawbacks to this strategy, notably its restricted application to drugs with high doses. This piece seeks to provide a thorough rundown of current advancements in the possibility applications of Liquisolid systems. It also offers insights into new techniques based on Liquisolid technology, which aim to further enhance its commercial feasibility.

Keywords: Liquisolid, flowability,





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INTRODUCTION

Revolutionizing Solubility Enhancement: Exploring Liquisolid Systems(1). In recent years, there has been a growing concern regarding the limited aqueous solubility of many active pharmaceutical ingredients (APIs) available on the market. This issue, coupled with the greater number of potential medication candidates characterized by very hydrophobic structures & poor has an ability to dissolve in water aqueous led researchers to focus their efforts on developing innovative formulation approaches to improve the bioavailability of orally administered drugs(2). Several strategies have emerged as potential solutions to enhance solubility and dissolution rates, including particle size reduction techniques such as API micronization, improving API digestion fluids elimination through compositions based on lipids in capsules made of soft gelatin and modifying the strong style properties of APIs, such as using amorphous solid dispersions. While these approaches have shown promise in laboratory settings, their clinical translation has proven to be highly challenging(3). One of the main obstacles to overcome in the industrial production of these formulations is the complex and costly nature of their manufacturing processes. These processes often require specialized equipment and analytical methods for quality control, making growing up challenging and resulting in a poor repeatability from pair unit to unit. Additionally, certain formulation strategies utilize organic solvents or energy-consuming procedures that not only both increase environmental concerns and the carbon impact(4). Amorphous solid dispersions, for example, are widely researched and utilized but have a limited number of marketed products due to physical stability issues and the challenges associated with manufacturing methods such as solvent-based techniques (e.g., spray drying) and melting methods (e.g., hot melt extrusion).

Factors such as thermal or mechanical stress during the manufacturing process can lead to physical instability, including the conversion of the API from an amorphous to a crystalline form(5). In response to these issues, liquisolid technology has become a viable, easy-to-use, and reasonably priced method of improving bioavailability. This method has attracted a lot of scientific attention in the last ten years, not only for increasing the pace at which poorly soluble APIs dissolve, but also for creating solid dosage forms that contain liquid APIs or herbal extracts as well as modified-release formulations. The literature has yet to offer a thorough analysis of the numerous uses of liquisolid systems, including innovative liquisolid-based technologies(6). This paper aims to fill that gap by reviewing the potentials of liquisolid systems for various applications and examining the challenges associated with their manufacturing in industrial settings. Liquisolid systems offer a streamlined and cost-effective alternative to more complex techniques, and novel solutions to overcome their limitations will be explored. By providing a comprehensive overview of liquisolid-based technologies, this review aims to pave the way for their wider adoption in the pharmaceutical industry(7).

Method for forming liquid-solid systems

Soft gelatin capsules with an API liquid dispersion are frequently utilized to speed up the API's disintegration and increase its bioavailability. This method is very helpful when creating granular dosage forms for APIs that are oily liquids. However, making gelatin capsules that are soft is a costly procedure that calls for specialized equipment. The idea of "powdered solution technology" was created in the 1990s to solve these problems(8). With powdered solution technique, an API is simply dissolved in a liquid or inert aqueous solvent together with a powder that can absorb the liquid, such cellulose or silica. This combination creates a dry, flowable powder. Powdered solutions offer the advantage of rapid release of the poorly soluble API due to the fact that it currently exists in solution, much like gelatin capsules that are soft. However, this concept had restricted industrial application as a result of poor the material's propensity to flow and condense of the resulting powder. Compression of these formulations often resulted in the fluid "squeezing out" phenomenon, leading to the depletion of a specific volume of API Consequently, the development of liquisolid (LS) systems emerged as a subsequent technology that simultaneously addresses crushing properties as well as permeability(6). By choosing appropriate carriers and coating materials that can absorb the liquid API while maintaining the proper flowability and compressibility, liquidsolid systems improve the formulation. This method makes it possible to create solid dosage forms that are similar to soft gelatin capsules but have better commercial usability for less water-soluble APIs. Liquisolid systems offer a workable substitute for





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powdered solutions by taking into account the concepts of both the ability to flow and enlargement. These systems facilitate the formulation of solid dosage forms with improved dissolution rates while maintaining acceptable flowability and compressibility during manufacturing(9). The phrase "LS systems" refers to mixtures of liquid and powder that have sufficient flowability and compression qualities as well as the appearance of being dry and non-adherent. What is referred to as a liquid or a liquid pharmaceutical is a solution/suspension of a highly dissolved in water API in an inert, water-miscible solvent or a liquid lipophilic API. The powder used to make LS systems is composed of a carrier material that is porous, able to absorb liquid into the inner pores as well as to adsorb the extra liquid onto the surface of the particles, and an outer layer that has highly adsorptive, tiny particles ready to adhere any remaining fluid from the come up of the carrier fragments filled with the liquid drugs. A lubricant, binder, disintegrant, and additional excipients as needed are added to LS powder to create tablets or capsules. The linked patent, which underlined that a certain transport and substance coated system may retain just a specific amount of liquid while maintaining sufficient flowability and compression properties at the same time, tried to assure the practical viability of this concept. I've provided a mathematical method for building LS systems as a consequence.

An essential metric is the carrier to wrapping ratio (R), which represents the proportion between the amounts of the transport (Q) and wrapping (q) components. The "flowable liquid load factor" (Lf), which represents the highest liquid load that still yields acceptable flowability, may be found by utilizing the "liquisolid flowability test" for a specific R value. The liquid load factor (Lf) is the amount that indicates the mass in the fluid (in grams) in relation to the mass of the carrier (in grams). The "angle of slide" limiting value for the flowability measurement employed by the prior "powdered solution technology" was 33°, however LS systems can monitor the commonly used powder flow rate. An LS powder should exhibit consistent flow without blockages, and the limit value for powder flow rate should be selected in line with the specifications of the particular equipment used for additional processing (such as a placing or pill filling machine)(10). Systems that include liquid and powder yet seem dry, are non-adherent, and have sufficient flowability and compression qualities are referred to as "liquidsolid" (LS) systems. The liquid part of LS systems can be a liquid hydrophilic API or a solution/suspension of a slightly dissolved in water API in an inert, water-miscible solvent. The powder used in LS systems is constructed of a permeable carrier material that can both absorb liquid into its pores and adsorb more liquid onto the surface of the particles. It also has a layer consisting of tiny, very adsorptive particles that may soak up any leftover fluid from the transport particles that have the liquid prescription placed on them(11). LS powder and possible additional additives, such as lubricants, binders, and disintegrants, are combined to create instant or prolonged-release pills which are referred to as "LS compacts". In order to ensure the actual practicality of this innovation, the related patent underlined that a certain system of transport and coating substances can only retain a predetermined amount of liquid while maintaining appropriate flowability and compression qualities(12).

To aid in the formulation of LS systems, a mathematical approach was stated. A crucial the carrier-to-coating ratio (R) is a variable representing the ratio of the carrier to coating material amounts (Q/q). The "liquisolid flowability examine" can be applied to determine the "flowable liquid load factor" (Φ Lf) for a specific R value. The proportion of the liquid's (W) to carrier's (Q) volume is known as the liquid load factor (Lf). Unlike the "powdered solution technology" that used the "angle of slide" method and a maximum value of 33 degrees to and to assess flow ability, LS systems commonly use the powder flow rate as an indicator of flowability. Based on the needs of the machinery used for later processing, such as tableting or capsule filling machines, the precise limitation value for the granule flow rate should be established. An LS powder should flow uninterruptedly at all times(13). Recognizing which problems can arise during the compaction process of LS admixtures with good flowability, a method called "the liquisolid compressibility test" has been suggested to evaluate the compactibility of LS systems on an industrial scale. The patent provides a thorough explanation of the steps involved for evaluating the compression properties greater amounts of the liquid phase and admixtures with various R values, along with the calculating specific physical attributes using mathematical equations of the powder excipients(6). The liquisolid compressibility test involves determining a parameter called "pactisity," This rates the greatest tablet hardness to crushing produced by the LS method's condensing of a one-gram tablet within the maximum squeezed force. A blend that can be compressed well should have a pactisity equal to or higher than 20 kg/g, and no liquid should squeeze out during compression(14).





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The highest possible liquid load that produces acceptable compressibility in accordance with the aforementioned requirements is taken into consideration when calculating the "compressible fluid weight ratio" (Lf). Finally, the ideal load factor (Lo), taking into consideration both flowability and compactability, should be calculated for a particular R value. In order to ensure the equilibrium between these two elements in the development of LS systems, mathematical formulae are utilized to determine Lo(15). The recommended mathematical equations provide a means to calculate excipient-specific formulation parameters, facilitating the determination of optimal amounts for a certain LS system. The requirements for a compressible admixture were used with these equations to determine developed based on the qualities of typical excipients comparable to silica and microcrystalline cellulose. It is important to note that when new excipients containing novel significantly increased adsorption capacity and specific surface area are used, these equations and criteria may need to be reassessed(16). However, the fundamental idea behind this formulation approach remains crucial: weighing the admixtures' flowability and compaction characteristics simultaneously. This principle is essential for expanding the applicability of the LS technology and ensuring the development of successful LS systems(17).

Ingredients in liquid-solid mixtures

The process of setting up an LS system follows a quick mixing process a simple, as depicted in Figure 1. Spireas (7) provided a detailed description of the preparation process using a mortar or pestle. In addition, a number of studies have shown that equipment such a fluid-based processor or an extruder/spheronizer, which are frequently utilized in the fabrication of LS systems, may also be used to create solid dosage forms(18). The participants necessary in the formulation within an LS system include a supporting substance, a coating material, and if the liquid medicine is transported in a liquid consists a suitable liquid and a dispersion of an API. These components work together to achieve the desired flowability and compression characteristics of the LS system. The carrier in an LS system should possess a porous structure and a high specific surface area, enabling it to absorb a significant amount of liquid. The most commonly used carrier is microcrystalline cellulose (MCC), but other conventional excipients such as amorphous cellulose, starch, lactose, and sorbitol have also been employed. In addition, As prospective carriers for LS systems, new extremely porous excipients with improved liquid absorption capabilities, including Syloid® XDP 3050 and 3150 (mesoporous, amorphous silica), Neusilin® US2, anhydrous dibasic calcium phosphate, and Fujicalin®, have been studied(19). LS compacts have utilized hydrophobic carriers for prolonged drug release, such as Eudragit® RL and RS, quad polymethacrylates. Once the pore inside of the carrier become saturated during the liquid phase, liquid is adsorbed and forms a layer on the carrier particles' exterior. The coating material, composed of Any extra liquid existing on the carrier particles is absorbed by the use of small particles, ideally those with a diameter of 10 to 5000 nm surface, maintaining the LS powder's appearance of aridity and unrestricted movement. Colloidal silica is the most commonly used coating material, but other excipients, and crospovidone have also been utilized as coating materials. LS systems use a different approach than rigid self-emulsifying drug delivery systems to boost the bioavailability of inadequately water-soluble APIs.

An API is simply dispersed or suspended in a hydrodynamic solvent in LS systems. A carrier and coating material are then employed to transform the API into a non-adherent powder. The liquid carriers employed in LS compositions must to have certain characteristics. To ensure that the liquid phase remains loaded on the carrier without necessitating a drying step, they should be inert, i.e., have a boiling point that is elevated. They must also be water-miscible organic solvents that are preferably not very viscous. The polymers ethylene glycol, fluid macrogols, glucose, and polysorbates are examples of appropriate fluid carriers for LS systems. Cremophor® ELIt has also been demonstrated that (macrogolglycerol ricinoleate) is a good liquid transport for LS systems including less soluble APIs(20). When choose a liquid vehicle, the solubility of the API should be taken into account. A lower requirement for porous excipients may lead to a lower tablet weight if the API is more soluble in the chosen solvent. In addition, a larger percentage of molecularly distributed API might contribute to a faster dissolution rate. Additional excipients are often required in order for the LS compacts, whether in tablet or capsule form. For immediate-release LS preparations, the inclusion of disintegrants is crucial to facilitate rapid the LS compact is wetted and disintegrated to ensure that the disintegration process does not constitute a limiting factor for medication dissolution. Disintegrating agents such salt starch glycolate, croscarmellose sodium, and the medication are commonly used in LS formulations.





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It may also be necessary to incorporate a suitable lubricant into the LS compact formulation to improve the flow properties during manufacturing (13, 21). The inclusion of a binder or matrix-forming ingredient is required in the container of LS compacts with long-lasting release recommended to create a matrix structure that controls the release of the API over an extended period. Hydroxypropylmethyl cellulose (HPMC) is an example of a commonly used binder in sustained-release LS formulations. The binder helps to maintain the integrity of the compact and regulate the drug release profile(22).

Benefits and Drawbacks of Liquisolid Technology

As a method for creating solid medication forms containing a lot of liquid, the LS technology has various benefits.

These benefits include

- Poorly soluble APIs have a better dissolving profile and are more bioavailable.
- Capability to produce zero-order release kinetics sustained-release formulations.
- Generating hard dosage forms from liquid APIs (in pills or capsules) is a possibility.
- a straightforward, economical, and sustainable method of preparation .
- Use of standard manufacturing equipment for solid dosage forms.
- Interoperability with traditional excipients for LS system formulation.
- Potential for large-scale production due to its industrial applicability.

However, there are certain challenges associated with LS technology that require further research efforts. These challenges include: Because of the considerable amount of liquid carrier required, formulating LS systems with high dose APIs might be difficult, resulting in an undesirable single formulation weight. The API should be absorbed in the non-volatile vehicle of choice. Extensive research on the appropriate amounts of perforated ingredients for the solvent state. Despite the LS admixture looking dry and having adequate flowability, there may be compression issues when tableting on newer fast speeds tablet press. More thorough investigation of the compression actions of LS systems and the elements influencing them is needed in order to support the practical use of LS technology(23). To address the issues with high-dose APIs in LS compacts, polyvinylpyrrolidone (PVP) incorporation in the liquid phase has been suggested. PVP serves as an adhesive during contraction, enabling larger liquid loads while lowering the quantity of transport and coating substance required(23). Additionally, the presence of PVP inhibits API precipitation in liquid medicine that has been saturated water. New mesoporous ingredients have also been shown promise in enabling higher liquid loads and incorporating larger amounts of the API in LS systems compared to conventional carriers like MCC. However, there is still a need for additional changes to broaden the scope of the LS idea for high-dose APIs. New liquisolid-based approaches have been the focus of recent research to solve this problem. There are not many studies that look at how liquisolid systems condense. While some studies have analyzed mechanical properties such as crushing resistance and friability of liquisolid tablets, few have delved deeper into the factors influencing compaction behavior. Dynamic compaction analysis and mathematical models have been proposed as tools to better understand and optimize the LS tablet composition and manufacturing procedure(24). According to recent study, using the SeDeM Expert System to evaluate the ability to process of liquisolid systems may be useful. This system provides a useful tool for assessing the feasibility and optimization of LS system formulations. Further research efforts are needed to advance the understanding of compaction behavior and facilitate the industrial application of LS technology(25).

Liquisolid Technology Implications Improved disintegration of drugs

The LS approach has received a lot of attention as a way to improve the bioavailability and dissolution of APIs with low solubility. The enhanced drug solubility seen in LS systems has been attributed to a number of different causes. Among these mechanisms are:(26) A bigger percentage of the medication is molecularly disseminated when there are particles in the liquid carrier, which leads to a speedier drug release. Increased medication solubility in water thanks to the liquid vehicle's role as a co-solvent in the ecosystem at the point of contact between the LS dust particle and the water-soluble media. Improved wetting properties: The aqueous liquid vehicle has a small tension on its





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surface or acts as a contact-active agent, which makes it easier to wet powder particles(27). One class of drugs that has been extensively studied in LS systems is nonsteroidal anti-inflammatory drugs (NSAIDs), particularly those with low solubility belonging Group II of the Biopharmaceutical Categorization Scheme (BCS). For instance, a research by Javadzadeh et al. compared the dissolving rate of piroxicam in LS compresses with the one of conventional straight pressed tablets and stiff gelatin pills. The LS compacts used silica particles as the outer protective layer and microcrystalline cellulose (MCC) as the carrier, with polysorbate 80 chosen as the fluid phase based on solubility studies. The findings showed that the LS strategy significantly improved the pace at which piroxicam dissolved, with 100% of the API being released through the LS compacts in 10 minutes as opposed to 60% and 50% release from tablets and capsules, respectively. The same research team also looked at the effects of carrier type and age on the characteristics of piroxicam LS compacts, such as the pace at which they dissolve and how hard they are. After 9 months of storage under ideal circumstances, the study found that neither the compacts' hardness nor their rate of breakdown had appreciably changed(28). Similar to this, Tiong and Elkordy looked at the pace at which LS systems dissolve using MCC, colloidal silicon dioxide, and maize meal as the transporter, cover material, and disintegrant, respectively. When compared to directly compressed tablets of the same content, omitting the liquid phase, the LS approach revealed better dissolving rate.

Overall, LS systems have shown promising results in enhancing the Inadequately soluble rate of breakdown and absorption APIs, particularly NSAIDs, as well as further research continues to explore the potential of this technique. The studies conducted on LS systems have shown improved dissolution rates and enhanced bioavailability for various poorly soluble drugs. Different APIs have been formulated as LS systems, including indomethacin, ketoprofen, diclofenac sodium, nimesulide, methyclothiazide, carbamazepine, famotidine, griseofulvin, flunarizine, rosuvastatin calcium, itraconazole, ketoconazole, and others. For example, a study with piroxicam showed that LS compacts achieved a significantly higher dissolution rate compared to conventional tablets and capsules. Similarly, studies with other drugs like indomethacin, ketoprofen, diclofenac sodium, and nimesulide demonstrated improved dissolution rates when formulated as LS systems(29). In vivo studies have also been conducted to evaluate the dissolution rate and bioavailability of poorly soluble. For instance, a study with carvedilol as a model drug showed a statistically significant improvement in bioavailability from LS compacts in comparison to a pure drug suspension. Carvedilol from LS compacts was absorbed at greater rates and had greater levels in the blood, according to pharmacokinetic tests in rats. In another interesting investigation, to increase the solubility and anti-diabetic impact of pioglitazone, LS compacts were created.LS formulations were used in both in vitro dissolving trials and in vivo investigations in mice, and outcomes corresponded with plain crushed tabs having a liquid component and pure medication. The LS compacts improved drug release rate statistically significantly, with over 99 percent of the medication released in 60 minutes. Furthermore, the administration of LS compacts led to a significant reduction in blood glucose levels in mice, the which placebo medications did not accomplish. Overall, these studies highlight the potential of LS systems in improving the dissolution, bioavailability, and therapeutic efficacy of poorly soluble drugs(30).

The creation of a liquisolid that dissolves internally tablet

Compared to standard uncoated tablets, mouth dissolving pills (ODTs) provide a number of advantages, including a quicker onset of action and the ease of swallowing without water. This renders them especially useful for those who have difficulty ingesting, pediatric and geriatric patients, psychiatric patients, paralyzed individuals, and bedridden patients. There has been increasing research interest in formulating LS systems as ODTs for various poorly soluble APIs. For example, a Basalious et al. conducted research to develop felodipine. LS ODTs for the treatment of hypertensive crisis, when quick commencement of pharmacological action is critical. The best LS formulations used felodipine dispersed in macrogol 400 as a carrier (MCC PH 102 or silicified MCC), colloidal silicon dioxide as the covering material, crospovidone as a super disintegrant, and taste-improving excipients. The disintegration times of the LS ODTs ranged from 7 to 11 seconds in both vitro and in vivo. When compared to soft gelatin capsules and traditional tablets, silicified MCC-based LS ODTs showed a much higher rate of dissolve, according to in vitro dissolving experiments. In vivo experiments in adult individuals revealed that felodipine absorption was substantially quicker from through the mouth given LS ODTs having silicified MCC, indicating their suitability for





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emergency situations(31). Another study focused on the development of LS ODTs using zolmitriptan as a model API for the treatment of migraines. The goal was to see how different super disintegrants affected soaking time and breakdown. Crospovidone-containing LS ODTs had the quickest wetting and disintegration times. The selected LS formulation exhibited a much faster dissolve rate and a shorter disintegration time as compared to conventional ODTs. Moqbel and colleagues examined two methods for making ODTs from chlorzoxazone, a poorly soluble API. One approach involved conventional co-processed excipients prepared by direct compression, The other made use of LS innovation and an inert solvent called macrogol 400(19). Wetting, dissolution duration, and dissolving speed of LS ODT were shown to be impacted by formulation parameters, such as the carrier-to-coating ratio and the fluid capacity factor, needing careful modification. Compared to ODTs prepared utilizing co-processed excipients, LS ODTs showed quicker wetting and disintegration times as well as a greater dissolving rate. But in-vivo tests on individuals in good health revealed that LS ODTs were less palatable because of a gritty texture and heavier tablets. In summary, formulating LS systems as ODTs for poorly soluble APIs offers advantages such as faster onset of action and ease of administration. However, careful formulation optimization is necessary to achieve desirable characteristics in terms of disintegration time, dissolution rate, and palatability(32).

Preparation of altered release materials

Spireas and Bolton promoted the use of liquisolid technology to provide continuous pharmaceutical release and increase the efficiency of immediate-release formulations. Even the possibility that liquisolid techniques can achieve low-order delivery movement that are comparable to complex and pricey conventional pressure device pills has been raised. In this process, an adhesive or matrix-forming substance, such as HPMC(33), is added to a typical liquisolid formulation. somewhat different method for creating liquid-solid systems with continuous release was put out by Javadzadeh et al. They used polysorbate 80 as the solvent and employed hydrophobic carriers like Eudragit® RL or RS. The model API propranolol hydrochloride, which is extremely water soluble, has the lowest solubility in polysorbate 80. LS compacts were created using HPMC as a binder and either direct compression or wet granulation. Comparing the two liquisolid preparation methods to traditional matrix tablets made by compressing the API, silica, and Eudragit® directly showed that the potential for prolonged release was larger with the liquisolid methods. The study made clear that in addition to the hydrophobic carrier, the liquid vehicle might be extremely important in producing extended drug release. It was advised to employ a liquid vehicle with a reduced API solubility for formulations intended for continuous release. Because it functions as a plasticizer, polysorbate 80 made it easier for a fine matrix structure to develop, improving API trapping within the material's network and the carrier chains' flexibility(34). Nokhodchi et al. used theophylline as an example API and applied a similar strategy. They discovered that in order to induce sustained release for weakly water-soluble APIs, HPMC may need to be added to liquisolid compositions with water carriers. It has been demonstrated that a co-solvent speeds up the API's dissolution.

Another research employing the extremely water-soluble model API venlafaxine hydrochloride showed that independent of the carrier type When employing polysorbate 80 as the inert fluid with the least solubility for the API. medication release was slower than when using macrogol 400 or propylene glycol. According to the study, raising the R value (which indicates a greater carrier and lesser coating material concentration) resulted in a delayed drug release. This was probably because the liquid medication diffused more slowly via a greater quantity of the porous transport material. In contrast to immediate-release liquisolid systems, sustained-release liquisolid formulations are frequently made with a greater proportion of coating material (lower R values, generally 10). Due to Eudragit® carriers' reduced potential for absorption, this is the case. This supports Nokhodchi et al.'s hypothesis that a higher concentration of very hydrophilic covering material - often colloidal silicon dioxide - correlates to delayed release of medicines in such compositions. Elkordy et al. also found that a liquisolid formulation with MCC as the medium of transport and colloidal silicon dioxide as the substance that coated it could be administered with sustained drug release using the selected liquid vehicle, Kollicoat® SR 30 D. This water-insoluble polymer was thought to be coated on the medication particles, reducing wet tability and decreasing the rate of disintegration. In a recent study, liquisolid technology was used to construct a bilayered core-in-cup buccoadhesive tablet for the treatment of hypertension. Liquisolid compacts containing olmesartanfor quick release made up the first layer, while azelnidipine for extended release made up the second. The intention was to increase azelnidipine's bioavailability, avoid the first-





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pass impact, and extend its release for a long-lasting therapeutic effect(35). The olmesartan liquisolid compact was made using Myglyol® 812 as the liquid phase, MCC as the medium for transport, and colloidal silicon dioxide as the coating material. Mannitol, sodium starch glycolate as a superdisintegrant, sodium carboxymethyl cellulose or chitosan as a mucoadhesive polymer, and magnesium stearate as a lubricant were all components of the final tableting mixture. The prolonged-release compact was produced using the mucous adhesive polymer, colloidal silicon dioxide, mannitol, azelnidipine, and dissolved poloxamer 188. Ethyl cellulose was added during the last compression cycle to enclose the double-layered pill and create a core-in-cup structure. According it in vitro release experiments, this method increased the in vitro dischargeof azelnidipine when compared to an actual combination while achieving a similar olmesartan release profile to that of commercially available reference immediate-release tablets. In contrast to distinct liquisolid compacts, the bilayered tablet shape had no effect on the dissolving profiles. In an in vivo pharmacokinetic study with human beings in good health using an immediate-release commercially available tablet as a control, olmesartan was rapidly absorbed and reached a higher maximum plasma concentration (Cmax) than the vehicle, while azelnidipine showed an extended release profile with an important boost in the extent of absorption(36).

Production of liquid herbal medicines in solid dosage forms

There are currently not enough research on improving different forms of dosage and resolving the stability concerns with this medications, despite the growing interest in herbal therapeutic items as alternatives to synthetic pharmaceuticals. The majority of oral herbal medications on the market now come in liquid dose forms like tinctures or syrups. The majority of oral herbal medications on the market now come in liquid dose forms like tinctures or syrups. Contrary to solid dosage forms, the use of liquid dosage forms includes the danger of dosing mistakes as well as the potential for unpleasant taste and stability issues. Herbal medicines in various forms are infrequently accessible, despite the fact that pills and capsules are generally recognized drug companies and consumers. Despite having benefits, soft gelatin capsules containing liquid herbal remedies are constrained by labor-intensive production procedures. Stiff collagen tablet and capsule forms are often created using wet plants that have undergone the expensive and time-consuming processes of freeze- or spray-drying. Additionally, the results of these drying processes may be very hygroscopic, which might cause stability problems(37). The drawbacks of these traditional approaches to the manufacturing of herbal medicinal products may be solved using liquidsolid (LS) technology. But just a few recent research have looked into the use of LS technology to create solid dosage forms using liquid plant extracts. An experiment, for instance, examined the effects of the manufacturing process (LS or freeze-drying) on the properties of granules containing oregano herb extract. In contrast to freeze-drying, LS systems that used Neusilin® US2 as both the medium for transport and covering substance carrier and coating material demonstrated easier and more affordable preparation. LS capsules and pills with frozen extract are contrasted, dissolution tests showed a greater release of active components (rosmarinic acid and carvacrol).

The selection of inertsolvents employed for collection also significantly affected how quickly active components dissolved. In comparison to freeze-dried extracts, LS systems showed greater flowability, while LS capsules demonstrated stability over the course of the test. In a different study, Curcuma comosa's oleoresin-like crude extract was converted into tablets using LS technology. A coating made of colloidal silicon dioxide was utilized MCC was used as the carrier, and PVP and propylene glycol (a non-volatile solvent) were added. Because of its high viscosity, the crude extract needed to be dissolved in 100% ethanol before being evenly distributed throughout the ethanol, a carrier, and a coating evaporation. Good flowability it demonstrated by the LS components, and tablets produced by compression had acceptable mechanical characteristics. These studies highlight a potential of LS technology as a promising method for the formulation of liquid and solid dosage forms herbal extracts, offering benefits such as simplified preparation, improved dissolution profiles, and enhanced stability. Further research in this area is needed to explore the full potential of LS technology for herbal medicinal products. The authors of the mentioned studies observed several positive effects of using the LS (Liquisolid) technique for the formulation of herbal medicinal products. In the instance of an LS system including oregano herb extract, a drop in the R value and an increase in dissolution as shown by a shorter crushing and disintegration time were both noticed. This more rapid dissolving was due to accelerated disintegration and an increase in colloidal silica, which provided a greater area of surfacethe





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dissolving medium must be introduced to the sample. The dissolution characteristics of the extract's main active compound were significantly improved compared to the crude extract when formulated into the LS system. However, It was shown that the addition of a non-volatile solvent slowed down the breakdown and delayed the disintegration process in the case of LS complexes containing turmeric comosa material the better dissolution was predominantly brought about by the larger surface area available for dissolution (38). In a separate investigation, LS technology was used to manufacture colorectal-targeted delivery tablets that included organic violet rice bran oil, a supplement for the treatment of colorectal cancer. Utilizing MCC and colloidal silicon dioxide, Before compressing the powdered oil into tablets, a modified version of the LS method that included wet crushing with PVP water in the two solvents is was used. To ensure targeted colon release, Eudragit® L100 and Eudragit® NE30D were coated on the final tablets. Studies on in vitro dissolution showed that LS technology has the ability to transform liquid active ingredients or oils into solid dosage forms appropriate for targeted distribution. An natural antioxidant with limited solubility called silymarinand low bioavailability, was also investigated for its suitability in LS formulation. To increase the drug loading capacity, silymarin was dispersed in propylene glycol and then a viscosity-increasing substance (PVP K30 or HPMC) was added. The coating substance was colloidal silicon dioxide, and MCC was utilized as the carrier. The firm gelatin capsules were filled with the produced LS admixtures. The dispersion rates and extents of the LS capsules were much better than those of pure silymarincapsules. The type and concentration of the viscosity increasing agent influenced the dissolution behavior, with the best results obtained when using PVP at a higher tested concentration (40%). Compared to pure silymarin, silymarin from the LS formulation had a stronger cardioprotective effect, according to an in vivo research done on rats.

Overall, these research demonstrate the potential of LS Innovation in enhancing the dissolution and delivery of active compounds from herbal medicinal products, allowing for improved bioavailability and targeted release(39). For the production of tablets comprising liquid extracts of numerous Rosaceae plants, a modified LS (Liquisolid) approach has been developed in recent studies. The tableting mixture, which in this enhanced approach also includes an LS admixture and other relevant excipients such filler, disintegrant, and lubricant, is compacted before being dried. The solvents used for extraction (ethanol or water) are meant to evaporate during this drying process. Neusilin® US2 is the carrier and colloidal silicon dioxide is the coating component used in the production of LS admixtures. The authors of these studies concluded that this modified LS approach can yield tablets with good physical features. These pills quickly dissolve and disintegrate, which may increase bioavailability. Additionally, The researchers claimed that this method can increase the antioxidant content of the tablets and enhance the stability of the extracts. As a result, this modified LS technique may enhance the overall efficiency of the herbal medicinal products, while also eliminating the need for producing an intermediate dry extract(40). Overall, the modified LS technology described in these studies shows promise for the formulation of tablets with liquid extracts, offering advantages such as improved bioavailability, increased stability, and simplified production processes.

Variations in pH value have a less impact on medication dissolving rate

El-Hammadi et al. conducted a study to examine the possible use of LS systems in decreasing the impact of pH variations on the weakly water-soluble API loratadine's rate of dissolution. To make LS tablets, propylene glycol was utilized as the liquid carrier, MCC as the carrier and filler, sodium starch glycolate as the disintegrant and colloidal silicon dioxide as the coating material. Dissolution studies were conducted in medium with varying pH values (1.2, 2.5, and 5) to determine the impact of pH variations in stomach juice. outcomes showed that LS systems might speed up loratadine's stomach absorption, irrespective of being fed or fasted. The rate of release of in LS tablets was substantially greater than inloratadine compared to especially at higher pH levels, immediately crushed ordinary tablets and commercial tablets. A similar whilst using telmisartan, another API with solubility based on pH, also showed improved dissolution and pH-independent release when the liquisolid technique was applied. These liquisolid formulations' better wetting and increased API surface area exposed to the dissolving medium were credited with the formulations' improved dissolution performance, facilitated by molecular dispersion inside the solvent that is water soluble(41). Badawy et al. lessened the effects of pH fluctuations and accelerated the dissolution of mosapride citric acid in pills using liquidsolid technology. An improvement in the rate and breadth of API dissolution was seen in dissolution tests utilizing biorelevant dissolving medium, together with a diminished effect





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of the pH level of the dissolving medium. The presence of a hydrophilic solvent in the liquisolid formulation was proposed to diffuse into the dissolution medium, acting as a co-solvent and leading to the API's enhanced thermodynamic activity, which led to almost pH-independent dissolution. Moreover, LS compacts had a higher bioavailability of mosapride citrate than commercial tablets, according to an in vivo pharmacokinetic investigation in healthy adult volunteers(42). The LS technique has also been explored for improving the active compounds' photostability when subject to deterioration. A study using amlodipine as a model substance investigated the photoprotective effect of LS systems. Nanometer-sized silicon dioxide and titanium dioxide were used alone or in combination to coat the MCC as a carrier in the formulations. admixtures exhibited a higher content of amlodipine (~97%) compared to conventional film tablets (~77%) after exposure to light, demonstrating that the LS method may be an effective substitute for film coating for enhancing the photostability of drugs. In summary, these studies demonstrate the potential of LS systems in reducing the influence of pH changes on drug dissolution, enhancing the solubility and dissolution of APIs with pH-dependent characteristics, and improving the photostability of susceptible substances.

New methods based on liquid-solids

In order to permit greater liquid loads while preserving improved flow and compression characteristics, the LS method has hurdles that must be solved, The LS technology has undergone a number of revisions. One method combines wet granulation with the liquisolid technique. In a research that recommended wet granulating LS powder before tableting, the powder was ground using a 10% PVP solution in water. In comparison to the ungranulated admixture, the produced granules demonstrated enhanced flow characteristics. It was possible to compress the granulated grains into tablets with satisfactory mechanical properties, and glibenclamide from the tablets' in vitro dissolving rate was favourably impacted by the granulation process. A similar strategy was suggested by Suliman et al. and is known as "water granulated LS formulations" In this technique, the last additives were added after water was supplied as a liquid glue to the drug's distribution in a fluid vehicles. The addition of solution as a liquid phase improved the flowability of the LS admixture, and the compacts prepared using this method exhibited higher pactisity compared to ones made using the traditional LS technique. The novel production process with wet granulation increased the proportion of norfloxacin released, according to in vitro dissolution experiments, Nevertheless, depending on the liquid vehicle utilized, the increase's importance varied(43). Another interesting concept called "liquisolid pellets" Pezzini et al.'s idea was put forth. a novel approach of multiparticulate system preparation, combining the using the extrusion-spheronization approach with the LS methodology.

A glue (copovidone aqueous solution) is introduced after the standard LS preparation is finished. The resulting mass is then extruded, spheronized, dried, and dried to produce pellets using a bed-in-fluid technique. As a model drug, felodipine was dissolved in macrogol 400 or Cremophor® EL, a non-volatile solvent. Crosspovidone was used as a coating and disintegrating agent, while MCC was employed as the carrier. Compared to ordinary pellets, LS pellets showed lower size, wider pore diameter, and higher volume. The kind of non-volatile solvent and the concentration of the disintegrant had an impact on the dissolve rate of felodipine LS pellets when compared to traditional pellets. The same research team used this technique in a related trial to increase the pace at which the antiviral medication ritonavir dissolves in the body. These modifications to the LS technique, including wet granulation and liquisolid pellets, offer potential solutions to enhance the flow, compression, and dissolution properties of formulations, expanding the applicability of the LS technology in industrial settings. Crosspovidone was utilized as a coating agent and a disintegrant in the preparation process previously mentioned, whereas MCC acted as both a carrier and a binder.Two non-volatile solvents were used: macrogol 400 and Cremophor® EL. The study noted that one development of the LS pellet technology was the addition of greater dosages of API, which addressed a drawback of traditional LS tablets. The most rapid and extensive drug release was seen in LS pellets made with Cremophor® EL among the formulations examined, demonstrating the important role that the non-volatile solvent type plays in medication release from these systems(44). The formulation parameters (concentrations of the solvent, carrier, coating material, and disintegrant) were examined again by the same research team using a mixed experimental design to determine how they influenced the crucial qualitative traits of LS pellets. In a different recent study, the research team used the extrusion (water granulation)-spheronization technique and the liquisolid technology to





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create LS pellets. The carrier utilized was MCC, while the coating substance was either crosspovidone or silicon dioxide. The liquid phase consisted of an ibuprofen solution in macrogol 400. This accomplishment of LS pellets with an exceptional flowability and a very high liquid load (up to 52%) demonstrates the potential of this combined approach to speed up the dissolution of high doses of poorly soluble APIs while maintaining industrial viability. Thymus vulgaris's natural product and essential oil component carvacrol was researched as a potential active component for LS system development. Carvacrol LS matrices were made using PVP, stearic acid, or colloidal silicon dioxide in three distinct ways. Following that, the matrices were combined with other excipients and granulated using distilled water, followed pellets are created by extrusion and spheronization. The drug release profiles of all manufactured pellets were satisfactory, with PVP-containing pellets showing the best characteristics and the slowest rates of dissolution. LS technology and extrusion-spheronization are combined in a different method dubbed "liquimass technology," which was put out by Lam and colleagues. With this strategy, substantial liquid loads can be accommodated as dosage forms in liquid tablets or liquid pellets (filled into capsules), improving the solubility of poorly soluble APIs. Although comparable to the LS method, the final liquid-mass system differs from it in that it occasionally consists of a wet mass or paste that is intended for further processing as opposed to always being a freeflowing powder. The liqui-mass approach, which is comparable to LS technology, may be used to produce pellets or tablets with immediate or delayed drug release (45). As a model medication in their initial work, Lam et al. employed naproxen to create liqui-pellets using colloidal silicon dioxide as the coating and MCC as the carrier. As liquid carriers for the formulation, a number of solvents were chosen. In the specified technique of preparation, the To make the combination into a wet mass suitable for extrusion and spheronization, a suitable amount of deionized water was added. Following that, the pellets were dried at the proper temperature in an oven. The produced liquipellets showed good flow characteristics despite having a high liquid load factor (Lf=1). Liqui-pellets were found to release drugs more quickly than pellets without a liquid carrier, albeit the sort of liquid phase utilized had a big impact on how quickly the releases happened. The goal of subsequent experiments was to increase the rate of naproxen release from liqui-pellets by examining various formulation factors.

Lam et al. claim that liqui-tablets may be created by compacting liqui-pellets. They looked studied whether it was possible to produce tablets from liqui-pellets containing APIs that weren't very soluble, including naproxen and ketoprofen, while still achieving decent mechanical properties and drug release. The use of Neusilin® US2 and MCC as a carrier material improved the mechanical properties and rate of drug release of liqui-tablets. Liqui-tablets have been suggested as a practical substitute for liquisolid compacts when creating tablets containing greater concentrations of insoluble APIs. Propranolol hydrochloride's continuous release was likewise made possible by the technique by incorporating Eudragit® RS PO, a suitable polymer, into the liqui-mass system. The most crucial factor was acknowledged to be the polymer concentration influencing sustained drug release from liqui-tablets(6). The rate at which poorly soluble APIs dissolve has frequently been increased via particle size reduction. To enhance the dissolving of celecoxib from tablets, Nazem et al. utilized co-grinding with the LS method. The API was mixed with macrogol 200 and ground into a liquid drug that could be turned into a dry powder by adding the proper excipients. For comparison, a physical combination and regular LS pills were created. In the first 15 minutes, 7.5 times as much medication was released from the co-ground LS formulation as from the physical combination. Reduced particle size improved the drug's wettability and solubility in a non-volatile solvent, which was credited with this improvement. Recent studies have also looked at how the liquid phase of the LS technology may be modified. Tong et al. combined self-nanoemulsifying and LS methods to create tablets that improved oral bioavailability and compliance for vitamin K1 (VK1), an oily liquid generally given as an injection. VK1 and surfactants were added to an improved selfnanoemulsifying drug delivery system (SNEDDS), which was then transformed into an LS system employing Fujicalin® as both a carrier and a coating material. The required excipients were added to the resultant powder before it was compacted into LS tablets. More than 80% of the medication was released from the LS tablets in the first five minutes at pH 6.8, compared to 0% for the pure VK1 tablets under the same circumstances(46). LS compacts significantly outperformed conventional tablets in terms of Cmax (maximum plasma concentration) and AUC (area under the curve) in studies on the in vivo pharmacokinetics of beagle dogs. The relative bioavailability of the LS compacts was 200%, demonstrating increased medication absorption and bioavailability(47). In a study employing eplerenone, previously enhanced nanoemulsions (NE) of eplerenone were loaded onto MCC as a carrier, and





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nanometer-sized amorphous silicon dioxide served as the coating material. This strategy aimed to provide an oral solid dosage form with better drug absorption, reduced hepatic degradation, and greater bioavailability by fusing the benefits of LS technology with nanoemulsions(48). The LS systems including eplerenone nanoemulsions showed quick release, with 90% of the medicine being released in 45 minutes, in contrast to eplerenone nanoemulsions alone, which showed continuous drug release over a period of 4 hours. Pharmacokinetic data from in vivo studies on rabbits indicated that the rate and amount of drug absorption were improved when LS systems were utilized as contrast to eplerenone nanoemulsions and conventional tablets(49).

CONCLUSIONS

Over the past decade, LS technology has garnered significant research attention, leading to numerous potential applications and advancements that have surpassed its initial concept. This technique, known for its cost-effectiveness, environmentally friendly nature, and compatibility with existing solid dosage form manufacturing facilities, utilizes conventional excipients, making it highly feasible for commercial implementation. By leveraging LS technology, solid dosage forms can achieve greatly improved bioperformance, resulting in enhanced drug absorption, bioavailability, and therapeutic outcomes. Given its favorable characteristics and promising results, LS technology is poised to make a substantial impact in the field of pharmaceutical formulation and contribute to the development of highly effective solid dosage forms.

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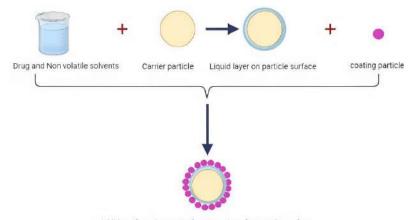




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Graphical abstract









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RESEARCH ARTICLE

Trends in pH of Cattle, Goat and Poultry Manure in Forced and Turning Method of Composting

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ABSTRACT

In India, the production of livestock products like milk, meat, egg and value added products is in increasing trend to meet the demand. The nutrient rich manure has a great impact on the environment and the bio waste generated from the sector is a concern because of high pollution. Properly treated livestock manure acts as a very good source of nutrients for plants. Composting is one of the methods used and among this forced aeration and turning method helps to improve the manurial value of compost. The changing trend in pH is an important parameter of concern before applying manure into agricultural land. Livestock manure co-composted with left over fodder has a great impact in reducing the pH and C/N ratio into ideal range. The present study is conducted to evaluate the trends in pH of cattle, goat and poultry manure in forced and turning method of composting.





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Keywords: pH trends, cattle, goat and poultry manure, forced and turning method, composting

INTRODUCTION

India has about 512.05 million livestock population and the amount of livestock waste generated was 1095 million tonnes annually (BAHS, 2019). Aerobic composting is regarded as an efficient and environmentally friendly method to dispose of organic solid waste. Composting helps in degrading and converting solid organic matters into stable humus-like matter by the action of microorganisms during the process, and the composting product could be served as organic bio-fertilizer and conditioner for farmland (Zhao *et al.*, 2016). Forced aeration accelerated the composting process, and compost matured after 36 days in forced aeration. According to He *et al.* (2011) the most effective way of recovering poultry manure was aerobic composting, which turned the organic matter in the waste into humus. Compared with continuous aeration, intermittent aeration increased O₂ supply efficiency, reduce the total GHG and NH₃ emission by Jiang *et al.* (2015). The quality of compost is mainly based on stability and maturity. Composts prepared from different organic wastes differ in their quality and stability, which further depends upon the composition of raw material used for the compost production. The pH value should be maintained at optimum range for a good quality compost.

MATERIALS AND METHODS

Location of study and sample collection

The present study was conducted at College of Veterinary and Animal Sciences, Mannuthy campus of Kerala Veterinary and Animal Sciences University, Pookode, Kerala. The experimental study was conducted for a period of 45 days in the months of February to March, 2023. Left over fodder collected from college farm was used as co-composting material, it was chopped into 1-2 cm size and fresh poultry manure collected from the Eco-farm, College of Veterinary and Animal Sciences, Mannuthy was added to the same. The poultry manure and co-composting material were mixed in 1:1 ratio. Treatment group comprised of six replicates of forced aeration and static bin composting (control). Perforated plastic bin was used for composting, which were placed under well aerated roofed area to protect them from adverse environmental conditions. The control group was set undisturbed during composting. In forced aeration treatment, air was passed through manure everyday through a combination of pipes using blower at four hours interval for five minutes from 8.00am to 4.00pm. The blower had an air volume of 1.2-3.0m³/min and flow rate of 0.17L min⁻¹ kg⁻¹ (Chowdhury *et al.*, 2014). Manual turning was done with a small garden shovel at weekly intervals (Zhang *et al.*, 2019).

Analysis

The pH value of the six treatment and three control groups compost was measured after diluting the sample with distilled water (1:10 W/V) (Lie *et al.*, 2012) using eco Tester pH2 at weekly intervals (Oviedo-Ocana *et al.*, 2015). Variables were analysed by One-way ANOVA followed by Duncan Multiple Range Test (DMRT) in each week. Between weeks of each treatment group repeated measures of ANOVA followed by least significant difference (LSD) test was done. Paired t-test was used for the comparison of initial and final value. Statistical analysis was done by SPSS 24.0 version as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSIONS

Cattle manure compost

The pH of cattle manure compost between different treatments at weekly intervals is presented in Table 1. The initial pH values between T1 and T4 treatments showed no significant difference compared to the C1. The pH value was higher in treatment T1 with a significant difference at p<0.01 in the second and fifth weeks of composting compared





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to the C1 and T4. Whereas T4 had a significant difference at p<0.01 during the first, third, fourth and fifth weeks of cattle manure composting. In cattle manure composting process, control group and turning method showed better trend towards ideal pH values compared to forced aeration. There were no significant differences in initial and final pH values (p>0.05) between the various treatment groups. Initial and final pH of cattle manure compost was non-significant among the different treatments and control group. The change in pH during composting was noticed during the composting process of the control, forced aeration and turning respectively. The pH of composted cattle manure in different treatments and control had no significant difference and it ranged from 8.61 ± 0.09 to 8.93 ± 0.15 , which was in line with the findings of Wang *et al.* (2004) and Sweeten (2008). Irshad *et al.* (2013) opined that the decrease in pH was due to the chemical composition of manure used with. The composted cattle manure had pH of 7.4 which was contrast to the present study.

Goat manure compost

The pH of goat manure compost between different treatments at weekly intervals is presented in Table 2. In goat manure composting, the pH in C2, T2 and T5 had no significant difference in the initial day. Also during the end of the first week, there were no significant differences in different treatment groups. Whereas, in second and third week pH had a significant difference at p<0.05, and T2 and T5 were significantly higher compared to C2.Treatment T2 had more significant differences (p<0.01) in the fourth week of composting compared to the other treatment groups. At the fifth week of composting, there was no significant difference in pH. In goat manure composting process, control group and forced aeration method showed better trend towards ideal pH values compared to turning method. At the end of composting, the pH was 8.69 ± 0.10 , 8.94 ± 0.11 and 8.96 ± 0.09 for C2, T2 and T5, respectively and there was no significant difference between the treatments. The pH of goat manure compost had no significant difference between treatments and control group in initial day of composting. The changes in pH of compost in control, forced aeration and turning methods after the experiment were 09.20±0.17 to 08.69±0.10, 09.15±0.12 to 08.94±0.11 and 09.20±0.14 to 08.96±0.09, respectively. The pH of goat manure after 45 days in different treatment groups and control was significantly different (p<0.01). According to Irshad et al. (2013) the composted goat manure had a reduced pH, which was similar to that of the recent study. Getahun et al. (2012) reported that the pH decreased because of organic acid decomposition. The values of final pH of goat manure compost were similar to the findings of Sweeten (2008), who found that the pH of finished compost ranged from 7.5 to 8.5 or greater.

Poultry manure compost

The pH of Poultry manure compost between different treatments at weekly intervals is presented in Table 3. The pH of poultry manure had no significant difference between the different treatment groups at the end of the first week. The pH changed significantly at p<0.05during the second, third and fourth weeks of composting. Forced aeration had a greater significant difference at p<0.01from the other treatments at the end of the third week. In poultry manure composting process, turning method and forced aeration method showed better trend in pH values compared to control group in poultry manure composting. The change in pH during the fifth and sixth weeks between treatments was significantly different (p<0.01). At the end of composting, treatments C3 and T3 had higher significant differences (p<0.01) compared to T6. Poultry manure compost satisfies the USEPA 1993 protocol, thus it is safe for use. Similar findings were noticed in the work done by Tiquia and Tam (2002) during the poultry manure forced aerobic compost.

CONCLUSIONS

In cattle manure composting process, control group and turning method showed better trend in pH values compared to forced aeration. In goat manure, the control group and forced aeration method showed encouraging trend in pH values compared to turning method in the composting process. In poultry manure to composting process, turning method and forced aeration method showed appreciable trend towards ideal pH values compared to control group. This implied that control, forced aeration and turning method helped to maintain optimum pH in the livestock manure composting process.





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Conflict of interest

The authors declare that they have no conflict of interest.

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Table 1.Mean pH value of cattle manure in different treatments

n.d.d	Treatments(Mean ±SE)			1	
Period	C1	T1	T4	p-value	
Initial	08.90±0.04 ^{AB}	08.83± 0.03 ^D	08.83± 0.04 ^D	0.373 ^{ns}	
Week 1	08.85±0.04 ^{ьв}	08.80±0.03 ^{bD}	09.18±0.07 ^{aAB}	<0.001**	
Week 2	08.83± 0.03 ^{cBC}	09.32±0.06 ^{aAB}	09.03±0.02 ^{bBC}	<0.001**	
Week 3	08.73±0.04 ^{bCD}	09.12± 0.05 ^{aBC}	09.20±0.04 ^{aA}	<0.001**	
Week 4	09.02±0.06 ^{bAB}	09.40±0.03 ^{aA}	09.38±0.10 ^{aA}	0.002**	
Week 5	09.03±0.04 ^{bA}	09.38±0.05 ^{aA}	08.95±0.03 ^{ьс}	<0.001**	
Week 6	08.85±0.04 ^{ьв}	09.05±0.05aC	08.93±0.05abCD	0.034*	
Week 7	08.63± 0.06 ^D	08.93± 0.15 ^{CD}	08.61± 0.09 ^E	$0.075^{\rm ns}$	
p-value	0.008**	<0.001**	0.006**		

Means with different superscripts a-c in row and A-D in column differ significantly ** Significant at 0.01 level (p<0.01); * Significant at 0.05 level (p<0.05); ns non-significant

Table 2. Mean pH value of goat manure in different treatments

n : 1	Treatments (Mean ±SE)				
Period	C2	T2	T5	p-value	
Initial	09.20± 0.17 ^{BC}	09.15± 0.12 ^{CD}	09.20±0.14 ^{BCD}	0.96 ^{ns}	
Week 1	09.27±0.15 ^{AB}	09.45± 0.06 ^B	09.33± 0.08 ^{BC}	0.458 ^{ns}	
Week 2	09.63±0.02 ^{bA}	09.73±0.02ªA	09.70± 0.03 ^{abA}	0.022*	
Week 3	09.37±0.04 ^{bA}	09.53±0.04 ^{aB}	09.47± 0.02 ^{abB}	0.018*	
Week 4	09.20± 0.04cBC	09.50±0.05aB	09.37±0.03 ^{bC}	<0.001**	
Week 5	09.15± 0.11 ^{BC}	09.42± 0.06 ^B	09.38± 0.07 ^{BC}	0.069 ^{ns}	
Week 6	08.80±0.21 ^{bCD}	09.28±0.09aC	09.40 ± 0.06^{aBC}	0.018*	
Week 7	08.69± 0.10 ^D	08.94± 0.11 ^D	08.96± 0.09 ^D	0.156 ^{ns}	
p-value	<0.001**	<0.001**	<0.001**		

Means with different superscripts a-c in row and A-D in column differ significantly ** Significant at 0.01 level (p<0.01); * Significant at 0.05 level (p<0.05); ns non-significant





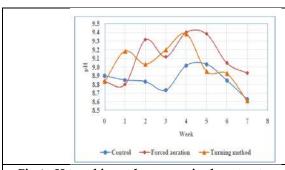
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Table 3.Mean pH value of poultry manure in different treatments

Treatments (Mean ±SE)				
Period		p-value		
Terrou	С3	Т3	T6	p-varue
Initial	08.85±0.04 ^{aAB}	08.88±0.04 ^{aB}	08.70±0.05 ^{bA}	0.032*
Week 1	08.90± 0.04 ^A	09.08± 0.06 ^A	08.93± 0.06 ^A	0.066 ^{ns}
Week 2	08.68±0.06 ^{aB}	08.37±0.02 ^{bC}	07.43± 0.13 ^{cBC}	0.001**
Week 3	07.48±0.12 ^{bC}	08.20±0.16 ^{aC}	07.40±0.06 ^{bC}	0.001**
Week 4	07.40±0.05 ^{bC}	07.37±0.04 ^{bD}	07.67±0.04 ^{aB}	0.001**
Week 5	07.48±0.09 ^{aC}	07.38± 0.04 ^{abD}	07.23±0.03 ^{bC}	0.039*
Week 6	07.42±0.14 ^{aC}	07.34± 0.05 ^{abD}	07.05±0.08 ^{bC}	0.044*
Week 7	07.31±0.06 ^{aC}	07.23±0.05 ^{aD}	06.75±0.06 ^{bD}	<0.001**
p-value	<0.001**	<0.001**	<0.001**	

Means with different superscripts a-b in row and A-D in column differ significantly

^{**} Significant at 0.01 level (p<0.01); * Significant at 0.05 level (p<0.05); ns non-significant



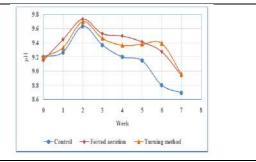


Fig 1.pH trend in cattle manure in three treatment groups

Fig. 2. pH trend in goat manure in three treatment groups

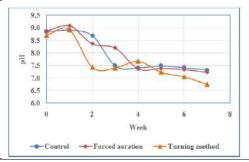


Fig. 3. pH trend in poultry manure in three treatment groups





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RESEARCH ARTICLE

Revolutionizing **Financial Artificial** Intelligence **Markets:** An **Investigative Study**

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ABSTRACT

Artificial intelligence (AI) has become increasingly integral to the financial market, revolutionizing how transactions are conducted, risks are managed, and investments are made. This abstract explores the multifaceted role of AI in finance. AI algorithms are adept at analyzing vast amounts of financial data with unparalleled speed and accuracy, enabling traders to make informed decisions in real-time. Machine learning models can detect patterns and trends in market behavior, providing valuable insights for predicting price movements and optimizing trading strategies. Furthermore, AI-powered risk management systems enhance portfolio management by identifying potential risks and implementing proactive measures to mitigate them. These systems can assess market volatility, credit risks, and operational risks, helping financial institutions safeguard their assets and comply with regulatory requirements. In addition to trading and risk management, AI-driven algorithms are utilized for fraud detection and prevention, enhancing security and integrity within the financial ecosystem. By continuously learning from data and adapting to evolving threats, these systems can effectively detect suspicious activities and prevent fraudulent transactions. Overall, the integration of AI technologies in the financial market has not only improved efficiency and profitability but also strengthened risk management practices, fostering a more secure and resilient financial system.

Keywords: Artificial Intelligence, Financial Market, Role of Artificial Intelligence, Market Behaviour, Risk Management.





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INTRODUCTION

The financial market landscape has undergone significant transformations in recent years, largely driven by advancements in artificial intelligence (AI) technologies. This introduction provides an overview of the evolving role of AI in the financial sector, highlighting its impact on trading, risk management, and fraud detection. In the past, financial decision-making relied heavily on human expertise and intuition. However, the exponential growth of data and the increasing complexity of financial markets have made it challenging for traditional approaches to remain effective. In response, financial institutions have turned to AI to harness the power of data analytics, machine learning, and natural language processing. AI algorithms are capable of processing vast amounts of data at unprecedented speeds, enabling traders to identify opportunities and execute transactions with greater precision and efficiency. By analyzing market trends, sentiment analysis, and historical data, AI systems can predict price movements and optimize trading strategies in real-time. Moreover, AI-driven risk management systems play a crucial role in assessing and mitigating various risks inherent in the financial market, including market volatility, credit risks, and operational risks. These systems leverage advanced analytics to identify potential threats and implement proactive measures to safeguard assets and ensure regulatory compliance. AI technologies are increasingly employed for fraud detection and prevention, enhancing security and trust within the financial ecosystem. Through continuous learning and adaptation, AI algorithms can detect anomalies and suspicious activities, enabling financial institutions to combat fraudulent transactions effectively.

Objectives

- To examine the impact of AI technologies on trading strategies and execution in the financial market.
- To assess the effectiveness of AI-driven risk management systems in identifying and mitigating various risks, including market volatility, credit risks, and operational risks.
- To explore the role of AI in fraud detection and prevention within the financial ecosystem, analyzing its ability to detect anomalies and suspicious activities.
- To evaluate the implications of AI adoption for market participants, including financial institutions, investors, and regulatory bodies.
- To identify challenges and limitations associated with the integration of AI in the financial market and propose strategies for overcoming them.
- To provide insights and recommendations for stakeholders on leveraging AI technologies to enhance efficiency, transparency, and trust in the financial industry.
- To contribute to the existing body of knowledge on the role of AI in finance and stimulate further research in this rapidly evolving field.

RESEARCH REVIEW

The following are some research papers that delve into the role of artificial intelligence in the financial market:

- "Artificial Intelligence in Finance: A Review and Future Directions" by Tomaso Aste et al. (2019): This paper
 provides a comprehensive review of the applications of artificial intelligence in finance, including trading, risk
 management, fraud detection, and regulatory compliance. It also discusses future directions and challenges for AI
 adoption in the financial industry.
- "Machine Learning for Financial Market Prediction" by Jürgen K. Hennig and Klaus Obermayer (2012): This paper explores the use of machine learning techniques for predicting financial market movements. It examines various algorithms and methodologies employed in financial forecasting and discusses their strengths and limitations
- "Deep Learning in Finance" by Hongyang Yang et al. (2020): Focusing on deep learning techniques, this paper
 investigates their applications in financial modeling, trading strategies, and risk management. It provides insights
 into the latest developments and trends in deep learning for finance.





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- "The Applications of Deep Learning on Traffic Flow Prediction in Financial Market" by Jie Fu et al. (2020): This paper explores the use of deep learning algorithms for predicting traffic flow in financial markets. It discusses how these techniques can improve trading strategies and decision-making processes.
- "Artificial Intelligence and Financial Services: Regulatory Challenges Ahead" by Marco Dell'Erba et al. (2019): Addressing regulatory concerns, this paper examines the impact of artificial intelligence on financial services and discusses the challenges posed by regulatory frameworks. It offers insights into potential regulatory approaches to ensure the responsible use of AI in finance.

RESEARCH METHODOLOGY

The research methodology employed in studying the role of artificial intelligence (AI) in the financial market involves several key components:

- Literature Review: Conducting a thorough review of existing literature to gain insights into the current state of research, identify gaps in knowledge, and understand the methodologies and findings of previous studies.
- Data Collection: Gathering relevant data from various sources, including financial market data, regulatory
 documents, academic papers, and industry reports. This data serves as the foundation for analysis and validation
 of research hypotheses.
- Quantitative Analysis: Utilizing quantitative techniques to analyze financial data and evaluate the performance of AI algorithms in trading, risk management, and fraud detection. This may involve statistical analysis, machine learning models, and other computational methods to extract meaningful patterns and trends.
- Qualitative Analysis: Conducting qualitative research methods such as interviews, surveys, and case studies to
 gather insights from industry experts, practitioners, and stakeholders. Qualitative analysis helps in
 understanding the practical implications of AI adoption in the financial market and identifying emerging trends
 and challenges.
- Model Development: Developing and testing AI models and algorithms for specific applications in finance, such
 as predicting market trends, optimizing trading strategies, and detecting fraudulent activities. This involves data
 preprocessing, feature engineering, model training, validation, and evaluation.
- Ethical Considerations: Addressing ethical concerns related to the use of AI in finance, including data privacy, algorithmic bias, and transparency. Ensuring that research methods and findings adhere to ethical standards and guidelines.
- Interdisciplinary Approach: Adopting an interdisciplinary approach by integrating insights from finance, computer science, mathematics, and other relevant disciplines. This enables a holistic understanding of the complex interactions between AI technologies and the financial market.
- Validation and Peer Review: Validating research findings through rigorous testing, peer review, and validation
 by experts in the field. This ensures the reliability and credibility of research outcomes and contributes to the
 advancement of knowledge in the field of AI in finance.

Data

Acquiring relevant data is crucial for researching the role of artificial intelligence in the financial market. Here are some potential sources of data:

- Financial Market Data Providers: Utilize data provided by financial market data providers such as Bloomberg, Refinitiv (formerly Thomson Reuters), FactSet, and Morningstar. These platforms offer a wide range of historical and real-time market data, including stock prices, trading volumes, market indices, and economic indicators.
- Publicly Available Datasets: Access publicly available datasets from sources like Yahoo Finance, Google Finance, and Quandl. These platforms provide free access to historical financial data for various assets, including stocks, bonds, currencies, and commodities.
- Government Agencies: Explore datasets published by government agencies such as the U.S. Securities and Exchange Commission (SEC), European Securities and Markets Authority (ESMA), and Federal Reserve System. These agencies often release reports, filings, and economic data that can be useful for research purposes.





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- Academic Research Repositories: Search academic research repositories such as SSRN (Social Science Research Network) and arXiv for research papers, datasets, and code related to artificial intelligence and finance. Many researchers share their datasets and findings publicly for academic and research purposes.
- **Financial Institutions**: Collaborate with financial institutions, banks, and investment firms to access proprietary datasets and market intelligence. These organizations may offer access to internal data, transaction records, and trading algorithms for research purposes under appropriate agreements and permissions.
- APIs and Web Scraping: Utilize APIs (Application Programming Interfaces) provided by financial platforms and
 data providers to access real-time market data programmatically. Additionally, consider web scraping techniques
 to extract data from financial websites and online platforms, ensuring compliance with terms of service and legal
 regulations.
- **Simulated Data**: Generate simulated financial data using mathematical models and simulation techniques. Simulated data can be used to test and validate AI algorithms and trading strategies under various market conditions and scenarios.

Statistical analysis with data for role of artificial intelligence in financial market

To perform statistical analysis on the role of artificial intelligence in the financial market, let's consider an example dataset containing historical stock prices and sentiment scores derived from news articles. We'll analyze how sentiment analysis, conducted using AI techniques, affects stock prices.

Dataset

- Stock Price Data: Daily closing prices of a specific stock over a certain period (e.g., one year).
- **Sentiment Scores**: Sentiment scores assigned to each news article mentioning the company associated with the stock. These scores indicate whether the sentiment of the article is positive, negative, or neutral.

Statistical Analysis

- **Descriptive Statistics**: Compute descriptive statistics such as mean, median, standard deviation, and range for both stock prices and sentiment scores. This provides an overview of the central tendency and variability of the data.
- Correlation Analysis: Conduct correlation analysis to examine the relationship between sentiment scores and stock prices. Calculate correlation coefficients (e.g., Pearson correlation) to quantify the strength and direction of the relationship.
- Regression Analysis: Perform regression analysis to model the relationship between sentiment scores (independent variable) and stock prices (dependent variable). Fit regression models such as simple linear regression or multiple regression to predict stock prices based on sentiment scores.
- **Hypothesis Testing**: Formulate hypotheses about the impact of sentiment on stock prices and conduct hypothesis tests to evaluate these hypotheses. For example, test whether there is a significant difference in stock prices between positive sentiment and negative sentiment days.
- Time Series Analysis: Apply time series analysis techniques to analyze trends and patterns in both stock prices and sentiment scores over time. Use methods such as autoregressive integrated moving average (ARIMA) modeling to forecast future stock prices based on historical data.
- Machine Learning Models: Train machine learning models, such as support vector machines (SVM), random forests, or neural networks, to predict stock prices using sentiment scores and other relevant features. Evaluate the performance of these models using metrics like mean squared error (MSE) or accuracy.
- Cluster Analysis: Explore clustering techniques to identify groups of stocks with similar patterns of sentiment and price movements. Cluster analysis can provide insights into market segmentation and investor sentiment across different sectors or industries.

Role

The role of artificial intelligence (AI) in the financial market is multifaceted and continually evolving. Here are some key roles that AI plays in the financial market:





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- Trading and Investment: AI algorithms analyze vast amounts of financial data, including market trends, news sentiment, and historical prices, to identify trading opportunities and optimize investment strategies. AI-powered trading systems can execute trades with speed and precision, leveraging quantitative models and machine learning techniques to generate alpha and manage risk.
- Risk Management: AI plays a crucial role in risk management by assessing and mitigating various risks, including market volatility, credit risks, and operational risks. AI-driven risk management systems employ advanced analytics and modeling techniques to identify potential threats and implement proactive measures to protect assets and ensure regulatory compliance.
- Fraud Detection and Prevention: AI algorithms are utilized for fraud detection and prevention within the financial ecosystem. By analyzing transactional data and detecting anomalies, AI systems can identify fraudulent activities and prevent financial crimes such as money laundering and insider trading. AI-powered fraud detection systems continuously learn from data and adapt to evolving threats to enhance security and integrity in the financial market.
- Customer Service and Personalization: AI technologies enable financial institutions to enhance customer service
 and personalize interactions with clients. Chatbots and virtual assistants powered by natural language processing
 (NLP) provide customer support, answer queries, and facilitate transactions. AI-driven recommendation engines
 analyze customer preferences and behavior to offer personalized product recommendations and financial advice.
- Compliance and Regulatory Reporting: AI helps financial institutions comply with regulatory requirements and streamline reporting processes. AI algorithms monitor transactions, detect suspicious activities, and ensure adherence to anti-money laundering (AML) and know your customer (KYC) regulations. AI-driven compliance solutions automate regulatory reporting and facilitate audit trails to demonstrate compliance with regulatory standards.
- Market Surveillance and Analysis: AI technologies assist in market surveillance and analysis by monitoring trading activities, detecting market manipulation, and identifying emerging trends. AI-driven market surveillance systems analyze trading patterns and detect unusual behaviors to maintain market integrity and prevent abusive practices.

CONCLUSION

In conclusion, the integration of artificial intelligence (AI) in the financial market has ushered in a new era of efficiency, innovation, and risk management. AI-powered algorithms enable traders to make informed decisions, optimize investment strategies, and execute trades with speed and precision. Moreover, AI-driven risk management systems enhance resilience by identifying and mitigating various risks, while fraud detection algorithms bolster security and integrity within the financial ecosystem. Additionally, AI facilitates personalized customer service, automates compliance processes, and enables market surveillance and analysis. As AI technologies continue to evolve, their role in the financial market will likely expand, driving further automation, transparency, and competitiveness. However, ethical considerations and regulatory challenges must be addressed to ensure responsible and sustainable adoption of AI in finance.

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REVIEW ARTICLE

Crystalline Chronicles: Navigating the Wonders and Worries of Plant Calcium Oxalate - A Review

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ABSTRACT

Embark on a journey through time and biology as we delve into the fascinating realm of calcium oxalate crystals in plants. From their historical roots in the 1600s to cutting-edge molecular insights, this research unveils the secrets behind these microscopic treasures. Discover the diverse roles these crystals play in plants – from calcium regulation to defence against herbivores and even acting as stress-busters. But beware, as we unravel the antinutrients effects, showcasing real-life cases where oxalate levels in food lead to unexpected health concerns. Not just silent witnesses, these crystals become plant detectives, aiding in taxonomy through unique shapes and locations. Uncover the techniques scientists employ to quantify oxalate levels, offering a glimpse into the methods shaping our understanding. Zoom into the gene level, where biotechnological interventions shed light on plant oxalate metabolism mysteries. Practical applications emerge as we explore methods to reduce oxalate in food, providing a guide for health-conscious and kidney-sensitive individuals. In this captivating exploration, we bridge the worlds of history, science, and health, offering a condensed yet comprehensive glimpse into the dazzling universe of plant calcium oxalate crystals

Keywords: Calcium Oxalate Crystals, Antinutrients Molecular Insights, Taxonomy, Health Implications, Dietary Practices, Biotechnological Interventions, Renal Health





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INTRODUCTION

Plants are the ultimate producers, providing sustenance to all living things on the planet on a sustainable basis since the beginning of time, therefore preserving the life cycle. They serve as food storage facilities for carbs, proteins, lipids, minerals, vitamins, fibers, and many antioxidants. Along with these nutrients, there are antinutrients that might cause small irritations to fetal responses when fed at levels that exceed permitted ranges. Among the oxalates found in plants, present in plants may act as an antinutrient by causing irritation to oral mucosa rash or dermitistis to skin hyper oxyluria or even renal failure develops in animals and humans, making a low oxalate diet essential for avoiding kidney stones.

Calcium oxalate Crystals in Plants

The study of crystals dates back to the 1600s, and it was Leeuwienhoek (1675) who reported the first existence of calcium oxalate crystalline structure in plants. Biomeneralization is the ability of plant and animal microorganisms to precipitate solid mineral depositions from ions assimilated by them, resulting in the formation of crystal deposition in them. McNazir discovered ergastic crystals in 215 different plant groups. According to Webb et al. 1995, calcium oxalate crystals are the most frequent bio mineral in the plant kingdom. The existence of calcium oxalate in plants has been observed at all stages of development, from embryonic to vegetative and reproductive. Studies have revealed the presence of crystals in roots, leaves, stems, seeds, floral organs, root nodules, and anther of plants..

Types of Calcium Oxalate Crystals

Calcium oxalate crystals are found in a range of distinct forms throughout plant tissues. Druses, raphides, prismatic, styloids, and sand crystals are the five most common crystal shapes (Gebura and Winiarczyk, 2016). According to Hartl et al. (2007), calcium oxalate monohydrate (COM) crystals were generally monoclinic druses, monoclinic styloids, raphides, rhomboid, and parallelograms, whereas calcium oxalate dihydrate (COD) crystals were tetragonal druses, aspherical aggregates, tetragonal styloids (prism), and (bi)-pyramids. Crystal formation in plants was discovered to be determined by genetic variables (Ilaeslan et al., 2001), although plant characteristics and crystal distribution were not varied by the influence of physical and chemical factors such as pH, temperature, concentration of various ions, water availability etc(Kuo-Huang et al., 2007).

Role of calcium oxalate Crystals in plants

Many functions have been assigned to calcium oxalate crystals in plant function. The most essential function of calcium oxalate crystals in plants, according to scientists, is calcium control (Zindler-Frank, 1975; Franceschi and Loewus, 1995). Excess calcium in response to plant needs, hence controlling calcium. Crystals were discovered to have a significant role in plant defense against grazing herbivores (Hudgins et al., 2003; Korth et al., 2006). Calcium oxalate crystals induced oral mucosal irritation and swelling, as well as digestive system oedema caused by oxalate grasses. Ergastic crystals were discovered to be connected with heavy metals such as zinc, magnesium, and cadmium, implying that crystals in plants play a role in heavy metal sequestration (Ma et al., 2001)...).. Oxalate was found to decrease aluminum toxicity in buck wheat by accumulating and sequestering in the symplast (Klug and Horst, 2010). Calcium oxalate crystals in plants have been linked to irritating compounds or proteoltyic poisons that irritate foraging herbivores (Rupali et al., 2012). After studying Peperomia glabella, another fascinating role of ergastic crystals was discovered, which was the adjustment of sunlight as a mirror to avoid photo-oxidation of chloroplast. Other than the overall idioblastic arrangement of crystals, a very particular pattern of druse crystal arrangement for each palisade tissue could be observed (Kuo-Huang et al., 2007). Crystals were found to play a function in anther dehiscence in Capsicum annuum studies (Horner and Wager, 1980). The provision of calcium to petunia germination tubes was discovered to be entirely provided by crystals stored in calcium oxalate crystals, which are recycled back to soil as the organs die and degrade, assisting in mineral cycling in soil. Even though calcium oxalate crystals were thought to be calcium stores and reserves, there was disagreement because the transport of calcium by phloem transport was not properly explained and calcium showed poor mobility in phloem. Paiva 2019 defined crystals as a plant mechanism for excreting excess calcium rather than a calcium reserve. This





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notion remains relevant because the plants lacked an excretory system for solid waste disposal, such as calcium salts. Broadley and White 2003discovered that calcium could not be relocalized via phloem and that calcium mobilization from older tissues to another site was impossible. Gilliham et al. (2011) discovered that calcium in vacuoles is rarely transferred in plants. Such findings supported the role of crystals as a plant excretory mechanism for excreting excess solid salts such as calcium. The role of ergastic crystals in fungal infections as a calcium ion detoxifier Sclerotinia sclerotiorum infection of Brassica carinata plants revealed that crystal concentration increased as fungal infection advanced in plants, implying its importance in chelating calcium molecules during infection (Uloth et al., 2015). In extremely ancient investigations (Umemoto and Hozumi, 1972) of Gingko biloba leaves for correlating atmospheric pollution and calcium oxalate crystal content, oxalate acid production was elevated as a stress response to carbon monoxide. The production of crystals was a stress-neutralization process in Gingko leaves by fixing oxalate with calcium ion. Calcium oxalate crystals have been found to serve as an anticoagulant. internal carbon source even when the stomata are closed, resulting in a new photosynthetic pathway known as alarm photosynthesis (Tooulakou et al., 2016).

Antinutrient Effects of Calcium Oxalate Crystals

Ananna et al. (2014) documented acute renal damage caused by starfruit (Averrhoa carambola) ingestion in human subjects in case studies. Common plants that have been known to induce severe allergic reactions deadly to humans include rhubarb (Sanz and Reig, 1992), star fruit (Neto et al., 2002), and sorrel (Farre et al., 1989). There have been case studies of several diets causing renal issues. Syed et al. (2015) described oxalonephropathy in a patient who took sixteen glasses of 8 oz black iced tea per day containing more than 1500mg of oxalate. A case report on juice dietinduced Oxalonephropathy was published by Getting et al. (2013). Kikuchi et al. (2014) investigated the use of herbal treatments for the treatment of liver cancer.) Discovered that chaga mushroom supplementation caused Oxalonephropathy. Haaskjold et al. (2015) described renal failure induced by an excess of almond consumption in patients with a lack of the bacterium Oxalobacier formigenes in their gut flora. Averrhoa bilimbi fruit juice used to lower cholesterol caused acute oxalonephropathy (Nair et al., 2014). (2013) (Bakul et al.). According to Nasr et al. (2006), excessive vitamin C usage as a health supplement caused secondary oxalosis. As a result, post-covid Vitamin C ingestion should be done with caution in renal patients. Patients with illnesses such as Type 1 diabetes have also been observed to develop secondary oxalate nephropathy as a result of rhubarb eating (Albersmeyer et al., 2012). The high oxalate concentration of fodder plants harmed bovine milk production and fat content (Rai et al., 2004). According to Bajaj et al. (2011), buffalo calves fed high oxalate Napier grass had lower rumen protozoa concentrations and thus lower rumen motility. Calves, on the other hand, had an increase in blood urea nitrogen and plasma creatinine. Herbivore sensitivity to oxalate poisoning was found to be dependent on characteristics such as oxalate chemical form, animal age, adaptability to oxalate forage, diet composition, and animal water availability (Rahman and Kawamura, 2011).

Ergastic Crystals as an Identification Tool in Taxonomy

Ergastic crystal shape and placement were shown to be quite specific among taxa and might be utilized as a taxonomic identification attribute (Lersten and Horner, 2000). Ergastic crystals are generated in specialized intravacuolar membranes or idioblasts (Contreras-Padilla et al., 201s). Calcium oxalate crystals might be monohydrate whewellite or weddellite. Cactaceae family members that were endemic to Mexico were analyzed to demonstrate that the species studied had varying degrees of hydration in weddellite crystals (Barcenas- Arguello et al., 2015). Vine cacti produced mono and dihydrate calcium oxalate crystals of varying morphology (Vinas et al., 2016). Many cacti species are identified purely on the basis of the crystal type found in them, as it can be a potential species level identification attribute in taxonomy (Frausto-Reyes et al., 2014). The identification of herbal spiral ginger Costus pictus among other common Costus species morphologically extremely similar to one other was accomplished solely by determination of calcium oxalate crystals (Nayagam, 2015).). Energy dispersive spectroscopy, infrared spectroscopy, and Raman spectroscopy were used to easily identify the hydration state of calcium oxalate crystals found in plants (Lopez- Macias et al., 2019). (2016) (Borrelli et al.). The presence of calcium oxalate crystals in the leaves of the extremophile plant Colobanthus quitensis (Kunth) Bartl of the Caryophyllaceae family was found to be related to ecotypic genetic adaptation rather than phenotypic plasticity (Gomez- Espinoza et





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al., 2021). The morphological and chemical nature of microscopic calcium has been a very important tool in archaeological studies. Assessment of fossil age (Hardy, 2004), identification of fossilised flora, identification of microfossil assemblages (Loy et al., 1992), and paleontological analysis of flora (Fullagar et al., 2006) have all been dependant on the morphological and chemical nature of microscopic calcium oxalate crystals.

Methods Essential for Calcium Oxalate Crystal Formation

Quantification numerous methods were utilised by scientists around the world in quantification of Oxalate in plant specimens, food samples, urine samples etc. Digital ImageQuantification Many methods have been used by scientists all around the world to quantify Oxalate in plant specimens, food samples, urine samples, and so on. ImageJ- Fiji v 2.0.0- rc69/1.52i could be used to do digital image analysis on microscopic pictures (Schindelin et al., 2012). This software-assisted technique assisted in turning qualitative data into precise and robust quantitative data of scientific significance. Zarembski and Hodgkinson (1962) and Hodgkinson (1997) reported on classic wet chemistry techniques such as colorimetric, gravimetric, and titrimetric estimations. The AOAC methods of permanganometric titration (1980) were frequently used for Oxalate quantification because they were accurate, inexpensive, and simple to execute with few chemicals and reagents. Ohkawa (1985) reported on the measurement of Oxalate in food samples using gas liquid chromatography (GLC). A synthesis of) applying the knowledge of various oxalate degrading and synthesising enzymes, but the technique was reported extremely sensitive.

Research at the Gene Level to Determine Plant Oxalate Metabolism

The precise mechanism of crystal formation in plants is yet unknown. Many unresolved oxalate metabolic pathways in plants were revealed by biotechnological treatments. The discovery of an oxalate synthesising operon in the phytopathogen Burkholderia glumae, which could be used to create transgenic Arabidopsis plants for studying oxalate metabolism, was groundbreaking (Nakata and He, 2010). Nakata (2012) proposed introducing two oxalate synthesising genes (obcA and obcB) from the phytopathogen Burkholderia glumae into a non-Oxalate synthesising Arabidopsis thaliana plant to study the physiology and expression of genes involved in Oxalate metabolism. He discovered that even non-oxalate accumulator plants had the basic oxalate synthesis machinery conserved in their DNA and could be revived with a signal. Many studies had been done on the gut residing bacteria Oxalobacter formigenes which was reported capable of degrading oxalate reaching the intestines of man and animals. A decreased level or absence of this microorganism in the intestines of patients have been found to be a reason for increased excretion of oxalate through urine -hyperoxaluria (Hatch and Frel, 2005the specific mechanism of plant crystal production is yet unknown. Biotechnological treatments revealed many previously unknown oxalate metabolic pathways in plants. The discovery of an oxalate synthesising operon in the phytopathogen Burkholderia glumae, which could be exploited to make transgenic Arabidopsis plants for researching oxalate metabolism (Nakata and He, 2010) was groundbreaking. To explore the physiology and expression of genes involved in Oxalate metabolism, Nakata (2012) proposed introducing two oxalate synthesising genes (obcA and obcB) from the phytopathogen Burkholderia glumae into a non-Oxalate synthesising Arabidopsis thaliana plant. He showed that even plants that did not accumulate oxalate had the basic oxalate production machinery conserved in their DNA and could be revived given a signalKim et al. (2008) investigated the role of oxalate in fungal-induced programmed cell death or apoptosis in plant tissues. When oxalic acid was utilized as the elicitor, Errakhi et al. (2008) discovered the need for anion channel activity in the generation of ethylene in apoptosis. These investigations clearly demonstrated the involvement of increasing oxalic acid content in aging and apoptosis. As a result, the oxalate concentration in early leaves and shoots was measured, and the genes responsible for this were identified. Overexpression of OXDC (Chakraborty et al., 2008), OXO (Walz et al., 2008), and AAEs genes was discovered to be responsible for oxalate reduction in plants. As a result, there is a strong genetic link.

Oxalate Metabolism in Plants

The study of oxalate metabolism in plants is still inadequate because the physiological linkages and products of oxalate metabolic pathways are not fully understood. There are various schools of thought on the oxalate precursor capable of crystal formation. Ascorbic acid was found as the precursor for oxalate metabolism (Kostman et al., 2001), and this is still widely accepted among scientists. Kites et al. (2000) found L-galactose and L-ascorbic acid to be the





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precursor molecules in calcium oxalate crystal precipitation in Pitsa stratiotes. They found ascorbic acid C2/C3 cleavage as the primary mechanism of oxalate production in plants. Other chemicals implicated in oxalate crystal formation by research include isocitrate, oxaloacetate, glycolate, and glyoxylate.. During the glyoxylate cycle and photorespiration, plants synthesise glycolate/glyoxylate by the enzymatic action of Glycolate Oxidase (GLO) and these glycolate and glyoxylate contributed to the synthesis of oxalate by its biosynthetic pathway (Yu et al.,2010).

Figure 1.Above shows that Biosynthetic and the degradation pathway of the oxalate (Taken from Caie al., 2015), Enzyme name full forms for abbreviations: 1.GLO- Glycolate oxidase.) OXAC- Oxaloacetate acetyl hydrolase, 3. MLS- Malate synthase, 4. MDH- Malate dehydrogenase, 5. CTS- Citrate synthase, 6. ACO- Aconitase, 7. ICL- Isocitrate lyase. & APX/AO- Ascorbate peroxidase/Ascorbate oxidase, 9. AAE3- Oxalyl-CoA synthetase. 10. OXDC- Oxalate decarboxylase, 11. OXO- Oxalate oxidase, 12. OXDE- Oxalyl-CoA decarboxylase, 13. FXH-Formyl-CoA hydrolase, and 14. FXDE- Fomate dehydrogenase. Chang and Beevers (1968) hypothesized oxaloacetate to be the precursor of oxalate synthesis in plants. They noted that Oxaloacetate Acetyl hydrolase (OXAC) was the enzyme responsible for oxaloacetate mediated oxalate synthesis in plants. They could also identify the genes responsible for it as Malate synthase (MLS), Citrate synthase (CTS), Malate dehydrogenase (MDH), Aconitase (ACO) and Isocitrate Lyase (ICL). Cai et al. (2015) compiled the various anabolic and catabolic pathways of Oxalate metabolism which summarizes all the precursors of oxalate synthesis and degradation in plants.

Techniques Used to Reduction Calcium Oxalate in Food

Wilting edible sections of two species of taro for 18 hours resulted in a 5.9% reduction in soluble oxalate level, according to research conducted in Central Vietnam. Soaking in water heated to 36-38 degrees Celsius resulted in a 26.2% reduction in soluble oxalate. The best approach for reducing soluble oxalate in cooked taro was to boil it for 60 minutes, which resulted in an 84.2% reduction in soluble oxalate levels (Hang et al., 2013). Another considerable reduction in soluble oxalate was reported when taro was boiled and baked with cow's milk. The experimental results showed that soaking taro com chips in baking soda for 2 hours followed by boiling at 90 degrees for 60 minutes can reduce soluble oxalate (Kumoro et al., 2014). Alcohol fermentation with Saccharomyces cerevisiae for 1 to 5 weeks reduced total oxalate content by 37-58% and soluble oxalate content by 39-59% in the juice processing of carambola fruits, which have a high CaOx concentration. Prolonged fermentation also resulted in greater oxalate reduction (Huynh and Nguyen, 2017). Purslane (Portulaca oleracea L.) leaves in raw salads with yogurt resulted in a significant decrease in soluble CaOx levels from 53% to a very low 10.7%. Moreau and Savage (2009) provide one example.

The Importance of Research on Ergastic Crystals in Plants

Juice diets (Getting et al., 2013), "green smoothie cleanses" (Makkapati et al., 2018), green leafy diets, and fruit and nut diets have all acquired popularity due to their purported health benefits, weight loss capabilities, and low-calorie intake properties. The underlying hazard of antinutrient accumulation and a lack of a balanced diet, on the other hand, may result in health problems such as renal failure, oxalate poisoning, oxalonephropathy, and even mortality. Until recently, calcium was thought to contribute more to kidney stone development than oxalate. The startling discoveries were made public between 2001 and 2004. Assimos et al. (2001) discovered that on a daily basis of 10-250mg oxalate, 24-539% of urine oxalate eliminated was entirely due to dietary oxalate and not calcium.. According to Holmes and Assimos (2004), kidney stone development is fully dependent on dietary oxalate absorption and excretion concentrations. Pak et al. (2004) discovered that calcium and oxalate have an equal role in the formation of calcium oxalate kidney stones. These findings from the early 2000s triggered a massive increase in pharmaceutical companies' study on oxalate load in medicine manufacturing for kidney stones. The dietary oxalate eaten was shown to be excreted to a range of 80-90% within an 8-11 hour time frame and 95-100% over a 24-hour time frame (Chai et al., 2004). These findings demonstrated the critical importance of managing dietary oxalate consumption. The Nutrition Care Manual published by American Dietetic Association (2005) restricts the permissible amount of total oxalate to <40-50 mg/100 g food sample for kidney patients and suggested 40-50 mg total oxalate/100g food sample per day as the standard permissible level for a normal person. According to Holmes and Assimos (2004), the development of kidney stones is entirely dependent on dietary oxalate absorption and excretion concentrations. Calcium and oxalate play similar roles in the production of calcium oxalate kidney stones, according to Pak et al.





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(2004). These early-2000s findings prompted a major rise in pharmaceutical companies' research on oxalate load in drug manufacture for kidney stones. The dietary oxalate consumed was shown to be eliminated at a rate of 80-90% within 8-11 hours and 95-100% within 24 hours (Chai et al., 2004). These findings highlighted the vital relevance of controlling dietary oxalate intake. Boiling vegetables was proposed as a method to reduce oxalate intake in renal patients if the boiled water was dis carded rather than consumed (Judprasong et al., 2006). Quite the contrary. Baking potatoes, roasting sesame seeds (Toma et al. 1979), or roasting peanuts showed no effect on their total oxalate level. The current study was inspired by a data gap regarding the oxalate content of regularly consumed vegetables, tubers, and fruits in India. The current study sought to better understand the properties of calcium Oxalate crystals found in a variety of leafy vegetables, subterranean stems, root vegetables, and fruits that were consumed raw or cooked and were an important part of the Indian diet. A comparison of total oxalate load in different vegetative parts of the plants under study was undertaken to generate data on calcium oxalate gradation in different organs of plants. Physical surface area occupied by crystals were analysed using software Image J and ZEN4, chemical analysis of total oxalate load was estimated by permanganometry, spectrophotometry and oxalate assay kit and gene level analysis using Real Time PCR or qPCR were conducted for an overall understanding of oxalate metabolism in plants. The study also intended to compare total phenol content and total oxalate content of the plants selected for study. Gene expression level study of oxalate synthesizing and degrading genes of selected plant exhibiting maximum total oxalate load was done to understand the genetic and phenotypic oxalate load dynamics. The data generated was expected to aid renal patients and borderline kidney stone patients to understand the oxalate levels in various vegetables and fruits so as to adhere to a low oxalate diet.

Future Research Opportunities

Studies on chemically mutagenized Medicago truncatula plants revealed a number of cm (crystal morphology faulty) and cod (calcium oxalate defective) mutants that were highly explanatory of CaOx crystal formation (McConn and Nakata, 2002). The isolated morphological mutants' genetic research demonstrated that a single mutation could result in substantial changes in crystal structure and size. CaOx crystal sizes and shapes varied in cmd plants, whereas oxalate content was over expressed and under expressed in cod plants in distinct point mutations. Mutation studies using chemical, physical, and gene level modifications to create oxalate deficient plants may aid in the development of zero-oxalate vegetables and crops safe for renal patients. Genetically engineered transgenic tomatoes engincered by inserting a gene expressing oxalate decarboxylase, which converts oxalate to formic acid and CO2 isolated from the fungus Flammulina velutipes, expressed 90% reduest, decrease oxalate in the fruits (Chakraborty et al., 2013). Transcriptome analysis of differentially expressed genes for determining the genetic makeup of calcium calcium oxalate expression in plants and then using it in genetically modifying trousers could be the future of antinutrient calcium oxalate management in food crops

CONCLUSIONS

The "Crystalline Chronicles" provide a thorough exploration of plant calcium oxalate crystals, revealing their diverse roles in plants and the associated health implications. From historical roots to cutting-edge molecular insights, and also highlights their significance in taxonomy, ecological adaptations, and potential applications in reducing oxalate in food. The study emphasizes the importance of ongoing research, suggesting possibilities for developing oxalate-deficient plants and genetically modifying crops. Overall, it offers a condensed yet comprehensive glimpse into the captivating world of plant calcium oxalate crystals, bridging history, science, and health.

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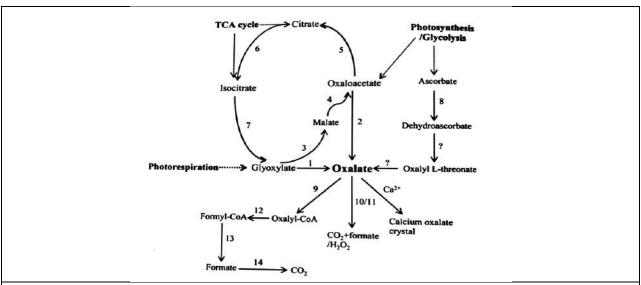


Figure 1. Biosynthetic and the degradation pathway of the oxalate

Figure 1. Above shows that Biosynthetic and the degradation pathway of the oxalate (Taken from Caie al., 2015), Enzyme name full forms for abbreviations: 1.GLO- Glycolate oxidase.) OXAC- Oxaloacetate acetyl hydrolase, 3. MLS- Malate synthase, 4. MDH- Malate dehydrogenase, 5. CTS- Citrate synthase, 6. AC0- Aconitase, 7. ICL- Isocitrate lyase. &APX/AO- Ascorbate peroxidase/Ascorbate oxidase, 9. AAE3- Oxalyl-CoA synthetase. 10. OXDC- Oxalate decarboxylase, 11. OX0- Oxalate oxidase, 12. OXDE- Oxalyl-CoA decarboxylase, 13. FXH-Formyl-CoA hydrolase, and 14. FXDE- Fomate dehydrogenase





RESEARCH ARTICLE

A Case Report for the Management of Madhumega viranam (Diabetic Ulcer) with Siddha Drug Chitramoola Kuligai

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ABSTRACT

Diabetes is an important non communicable disease affecting many people throughout the world. Diabetic leg ulcers are the complication of the above said disease that may lead to amputation if not properly treated. Traditional medicines derived from medicinal plants play a greater role in the management of various ailments. A male patient aged 50 years was admitted in the In-patient ward diagnosed with diabetic ulcer in the medial aspect of the Right leg near the ankle with itching, swelling in the peri-wound area, discharge, foul smell and pain for the past 1 year associated with diabetes for the past 5 years. PUSH scale tool was used to assess the wound healing process. Chitramoola kuligai (CMK) a herbomineral tablet formulation of Siddha indicated for ulcer was assessed for its efficacy in the treatment of Madhumega viranam (Diabetic ulcer) as internal and Mathan thylam for dressing as external medicine. Blood and biochemical parameters investigation were done before and after treatment. The wound was completely healed in 35 days and the post investigation result of blood and biochemical parameters were within normal limits. Thus, CMK exhibited its potency for the treatment of Madhumega viranam as indicated in the Siddha classical text apart from its regular prescription for the treatment of

Keywords: Diabetic leg ulcers, PUSH scale, Chitramoola kuligai, Siddha, Madhumega viranam





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INTRODUCTION

Leg ulcers may occur in many different diseases[1]. They most often appear in the lower leg. The more common types of leg ulcers are venous leg ulcers, arterial ulcers, and diabetic foot ulcers. The less common types of leg ulcer are caused by vasculitis, vasculopathy, necrobiosis lipoidica, pyoderma gangrenosum, malignancy, and hypertension[2].Diabetic foot ulcer (DFU) is one of the most significant complications that Diabetes patients face. Some of the significant causes of DFU include poor glycemic management, repetitive trauma, underlying neuropathy, peripheral vascular disease, and poor foot care. The prevalence of DFU is increasing globally, and more people are suffering due to inadequate information and precarious economic conditions. The global DFU incidence was 8.5%[3]. DFU has been reported to be more prevalent in males than females[4]. According to DFU statistics in India, 25% acquire DFU, 50% become infected, and around 20% require amputation. Notably, DFU contributes to nearly 80% of amputations in India each year[5]. Siddha is a traditional form of medicine originated in south India. Herbal and herbo-mineral formulations are commonly used in Siddha system of Medicine for various ailments. In Siddha system, diabetes is called as Madhumegam and diabetic ulcers as Madhumega viranam[6]. According to Siddha treatment, the therapeutic for diabetic foot ulcers include both internal and external medicine. Chithiramoolakuligai(CMK)is a herbomineral tablet formulation indicated for the treatment of ulcers and cancers[7]. Though, CMK tablet is indicated for ulcers, it is mainly used in the out-patient department (OPD) by the physicians for the treatment of cancer. The efficacy for the treatment of ulcers was not analysed so far and hence the present study was done to rule out its potency in the treatment of ulcer.

Case presentation

Informed consent

Informed consent in written format was obtained from the patient for disclosing his reports accompanying with images and publishing without revealing his identity.

Case study

A male aged fifty years from Arani, Tamil Nadu, works as a tailor was admitted in the In-patient ward of Aringnar Anna Hospital of Indian Medicine with complaints of ulcer present in the medial aspect of the right leg near the ankle followed by itching, swelling in the peri-wound area, discharge, foul smell and pain for the past 1 year. The ulcer first developed as a pinpoint wound which progressed later into 3 separate ulcers due to itching and subsequent scratching because of improper treatment. The patient went to a nearby clinic for treatment, but there was no improvement in the ulcer even after antibiotics and several dressings. As he was dissatisfied with the treatment, he visited Siddha Hospital for further treatment. He was diagnosed as Diabetic 5 years back and he was taking Metformin tablet500mg morning and night 1 orally. He was diagnosed as Madhumegaviranam (Diabetic Ulcer) present in the medial aspect of the right leg. He had a history of 3-4 cigarettes per day for the past 10 years and being an alcoholic for the past 10 years. He had stopped smoking and drinking alcohol for the past 6 months. Patient was admitted in the IPD Aruvai and Thol Maruthuvam (Surgery) College male ward, and the wound was examined. As per wagner's grading the ulcer falls under Grade 2[8]. After completing the appropriate examinations, the wound was cleaned and dressed with Mathan thylam. The wounds were analyzed and they measured length × breadth as 3.2 ×2.6 cm, 3× 2.4cm and a very small wound of size 1 × 1cm respectively. He had swelling, tenderness and pain on the wound affected areas accompanied with foul smell, pus and discharge. Blood samples were collected for investigations. Pressure Ulcer Measurement Tool (PUSH)was followed to measure the wound before and after intervention [9,10]. As per PUSH, the surface area, exudate, and type of wound tissue were measured. The analysis of the wound with PUSH, scored about 13/17, 12/17, 8/17 for the 3 wounds respectively. Madhumegachooranam(Antidiabetic siddha formulation)2gms twice a day and Chitra moola kuligai 1 tablet twice a day were prescribed daily for oral administration. Siddha medicines were administered for 5 weeks. Every day the ulcer was cleaned and dressed. Swelling in the peri-wound area was reduced on the fifth day. Granulation tissue started to develop on the 8th day. Pain was reduced and came to normal on the 15th day. Necrotic tissues were completely disappeared and granulation tissue were covered the wound area on the 25th day of the treatment. All the three wounds completely healed with





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covering of epithelial tissue on 35th day. The images of the healing process of the wound is shown from Figure 1-Figure 6. On the day of discharge, measurement of ulcer by PUSH tool came to 0/17. CMK tablet was instructed to take for further 1 week and Madhumegachoornam for 1 month and the patient was followed up for a month. No recurrence and adverse drug reaction was noticed during the follow up period

DISCUSSION

Traditional medicines are used by about 60% of world's population. Though, diabetes and its complications are reduced through various approaches, herbal formulations are preferred by the people due to its lesser side effects and low cost. The Siddha medicine CMK was chosen to treat the diabetic ulcer of a male patient who was admitted in the In- patient ward with Mathan thylam as dressing. Chitra moola kuligai formulation consists of *Plumbago zeylanica* as the main ingredient which was named after it (*Plumbago zeylanica*'sTamil name is Chitramoolam and kuligai means tablet)with *Carum copticum* and *Hydragyrum sub chloride*. Various research studies had reported that plumbago zeylanica has wide range of actions like anti-cancer, anti-diabetic, anti-inflammatory, anti-ulcer, anti-microbial and wound healing[11]. In this regard, the above drug is an appropriate choice for diabetic ulcer as it has all the necessary actions for wound healing process. Mathan thylam contains, *Datura metel*, *Acalypa indica* leaves juice, copper sulphate and coconut oil[12].In previous studies, Mathan thylam was reported for its anti-bacterial and wound healing property [13,14].Blood and biochemical investigation of the patient was done before and after treatment. Post investigation showed the blood, liver and renal parameters were within normal limits which ensures the safety of the drug CMK. Blood sugar fasting and postprandial came to normal in the post investigation compared to pre investigation which is an added advantage for the patient. The push score came to 0 and the patient's wound was completely healed at 35th day by Siddha treatment.

CONCLUSION

The Siddha medicine Chitramoola kuligai with Mathan thylamremarkably reduced the diabetic ulcer in a short span of time without leading to further complications which ensures the potency of the drug in the wound healing process. Hence, the present case study concludes that CMK is an effective drug for the treatment of ulcers.

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Table 1. Siddha treatment given for the Patient

Day	Treatment and Observation		
1st J	Patient was admitted in the Aruvai and Thol Maruthuvam(surgery) College IPD ward. The ulcer		
1 st day	was cleaned and dressed with Mathan thylam.		
2nd days	Blood and urine samples were given for Investigation. Chitra moola kuligai1 tablet bd as internal		
2 nd day	medicineand Mathan thylamfor dressing the wounddaily were prescribed.		
2rd doss	Madhumega choornam 2gms bd was added daily orally to manage his blood sugar along with his		
3 rd day	regular allopathic anti diabetic drug.		
5 th day	Foul smell, slough and discharge started to reduce. Swelling around the peri wound area reduced.		
8 th day	Foul smell, discharge and pus completely reduced. Granulation tissue started to develop.		
15 th day	Pain in the wound area completely reduced.		
25 th day	Granulation tissue covered the margins of the wound so the area of the wound became reduced.		
30 th day	Out of the 3 wounds, the smallest wound completely healed.		
35 th day	All the 3 wounds completely healed and covered by epithelial cells. Blood and urine samples given		
	for investigation.		
Follow up for	There was no recurrence of wound noticed.		
1 month.			

Table – 2 Haematological parameters pre and post treatment

Haematological parameters	Before treatment	After treatment
	(15/7/2023)	(18/8/2023)
Total Count(Cells/Cumm)	8000	8300
Neutrophils (%)	72	75
Lymphocytes (%)	22	21
Basophils (%)	0	0
Eosinophils (%)	6	4
Monocytes (%)	0	0
Haemoglobin (gm%)	10	12
*ESR(mm/hr)	28	16

*ESR- Erythrocyte Sedimentation Rate





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Table -3 Biochemical parameters pre and post treatment

Biochemical Parameters	Before treatment (15/7/2023)	After treatment (18/8/2023)
Fasting Blood Sugar (mg/dl)	111	86
Post Prandial Blood Sugar (mg/dl)	254	107
Urea (mg/dl)	35	24
Creatinine (mg/dl)	1.56	0.6
Total Bilirubin (mg/dl)	0.60	0.9
SGOT (IU/L)	10	15
SGPT (IU/L)	12	18
Alkaline phosphatase (IU/L)	113	110
Total Cholesterol (mg/dl)	190	188
Triglycerides (mg/dl)	89	85
HDL Cholesterol (mg/dl)	32	35
LDL Cholesterol (mg/dl)	135	122

Table 4. Push scale score

Day	Wound 1	Wound 2	Wound 3
1	13	12	8
5	11	10	6
10	9	8	4
15	7	6	2
25	4	3	1
30	2	2	0
35	0	0	





Fig 1.1st day

Fig 2.5th day





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RESEARCH ARTICLE

Towards High Gain Multi-Level Inverter Design for PV Systems

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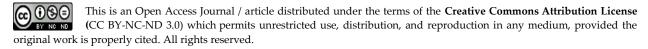
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ABSTRACT

Basically, two-stage power conversations are required to interface the PV systems to the grid or industrial loads. Firstly, high-gain DC-DC conversion which allows each stage to operate at its optimal efficiency point, maximizing overall energy conversion efficiency. Secondly, the inverter stage ensures that the generated AC power is synchronized, stable, and conforms to grid standards, maintaining power quality. For a more economical perspective avoid cost implantation for the DC-DC conversation for small-scale PV systems on the distribution side. In this paper, an efficient nine-level quadruple multilevel inverter (MLI) is presented. The proposed MLI works on the concept of the Switched Capacitor (SC) technique. For better turn on and turn off the SCMLI switches level shifting PWM technique is adopted. The proposed SC Multi-Level Inverters are particularly attractive for applications where high-quality AC output waveforms, reduced voltage stress, and improved power conversion efficiency with a reduced number of components.

Keywords: PV System, Power Quality, Multi-Level Inverter.





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INTRODUCTION

Solar photovoltaic (PV) power systems offer a range of important benefits that contribute to sustainable energy generation, grid stability, environmental conservation, and economic growth [1]. Grid-connected solar PV systems harness sunlight to generate electricity without emitting greenhouse gases or pollutants. They provide a clean and renewable energy source, contributing to efforts to mitigate climate change and reduce reliance on fossil fuels. Solar PV systems help reduce carbon emissions, air pollution, and water consumption associated with traditional fossil fuel-based electricity generation. This improves air quality, protects ecosystems, and mitigates the impacts of global warming [2]. Multi-level inverters can be integrated with energy storage systems to provide grid stabilization and the capability to store excess solar energy for later use [3-4]. Distributed PV systems with multi-level inverters can be integrated into smart grid frameworks, enabling real-time monitoring, remote control, and demand response [5].Diode-clamped (neutral-point clamped), flying capacitor, and cascaded H-bridge inverters are more popular viable MLI. Where diode clamped [6] MLI have lower voltage stress on switches compared to traditional two-level inverters and simplicity of control and modulation. Fewer power semiconductors needed compared to some other multi-level topologies. However disadvantages are Limited number of voltage levels. Reduced efficiency at lower modulation indices and requires voltage balancing among the capacitors. Flying Capacitor [7] Inverter has higher number of voltage levels compared to diode-clamped inverters and reduced voltage stress on switches. Improved efficiency at lower modulation indices compared to diode-clamped inverters. Disadvantages of FC are Complexity of capacitor voltage balancing and increased component count and cost due to multiple capacitors and limited power handling capacity due to capacitor voltage ratings. Cascaded H-Bridge Inverters [8] have highest number of voltage levels among the discussed topologies. Improved output waveform quality and better efficiency across modulation indices and flexibility to handle high power levels through series connection of H-bridge modules is possible [9-10]. Limitations with CHB is Increased number of power semiconductor switches, leading to higher cost and more complex control and modulation algorithms. Voltage balancing among the H-bridge modules is much more difficult.

System configuration

Broadly two categories are available to interface the grid or load to the PV such Two-stage grid interfaced PV system

A two-stage photovoltaic (PV) system refers to a configuration in which the PV power generation is split into two distinct stages or subsystems. Each stage performs a specific function to optimize the overall efficiency, power quality, or system performance. A two-stage PV system involves a Maximum Power Point Tracking (MPPT) stage. The main function of this stage is to extract the maximum available power from the PV panels under varying environmental conditions such as changing sunlight intensity and temperature [11].

Single stage grid interfaced PV system

In this case to deliver power to the A.C load a well operated multi level inverter can be opted. Multi-level inverters provide high-quality sinusoidal output voltage with reduced harmonics. This helps improve power quality by minimizing voltage distortions and reducing the potential for grid disturbances. Multi-level inverters can achieve higher efficiency compared to traditional two-level inverters, especially in medium and high-power applications [12]. This efficiency enhancement contributes to improved energy conversion and reduced losses. Reduced Multi-level inverters generate lower EMI due to their advanced switching techniques, contributing to a cleaner and quieter electrical environment. Multi-level inverters can regulate the output voltage more accurately, which is beneficial for maintaining voltage stability in the distribution network, especially during grid voltage fluctuations.

Proposed nine levels of MLI topology

A SCMLI uses a combination of capacitors and power switches to create a staircase-like waveform by connecting capacitors in different configurations. By selectively charging and discharging the capacitors and connecting them in series or parallel, multiple voltage levels can be generated at the output. These voltage levels approximate a sine





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wave, resulting in a higher-quality AC waveform compared to traditional two-level inverters. The switching pattern for nine levels of MLI for both positive and negative levels is depicted in Fig.2.

Positive Voltage Levels

Mode 1: In this mode only g_1 , g_6 and g_{10} switched are triggered and to obtain V_{out} =0. At the same time, Capacitor C_1 charges by turn on g_3 , g_4 , g_5 , and g_7 switches.

Mode 2: In this state to obtain $+V_{dc}$ as output voltage level, switches g_1 , g_6 , g_{10} , and g_{13} are triggered. Similarly no alters in capacitor C_1 switches operation. In this duration, C_1 charges up to V_{dc} and capacitors C_2 and C_3 in floating mode.

Mode 3: In this case switches g_1 , g_2 , g_7 , g_{10} , and g_{13} are turned on and capacitor C_1 is connected in series to the input PV source so $\pm 2V_{dc}$ voltage is available as output voltage. During this mode, the capacitor C_2 will be charged by turning on g_4 , g_5 , and g_8 switches and capacitor C_3 will be in floating condition.

Mode 4: In this mode to get the output voltage as $3V_{dc}$, the charged capacitors C_1 and C_2 are connected in series with the input PV source by triggering the switches g_1 , g_2 , g_3 , g_8 , g_{10} , and g_{13} . Simultaneously, C_3 is charged to V_{dc} by turning on the g_5 & g_9 switches.

Mode 5: To achieve +4V_{dc} output voltage level, capacitors (C₁, C₂, and C₃) are connected in series to the input PV source by triggering g1, g2, g3, g4, g9, g10, and g13 switches.

Positive Voltage Levels

Mode 1: In this mode, only g_1 , g_6 , and g_{10} switched are triggered to obtain V_{out} =0. At the same time, Capacitor C_1 charges by turning on g_3 , g_4 , g_5 , and g_7 switches.

Mode 2: In this state to obtain $+V_{dc}$ as the output voltage level, switches g_1 , g_6 , g_{10} , and g_{13} are triggered. Similarly, no alters in capacitor C_1 switches operation. In this duration, C_1 charges up to V_{dc} and capacitors C_2 and C_3 in floating mode.

Mode 3: In this case switches g_1 , g_2 , g_7 , g_{10} , and g_{13} are turned on and capacitor C_1 is connected in series to the input PV source so $\pm 2V_{dc}$ voltage is available as output voltage. During this mode, the capacitor C_2 will be charged by turning on g_4 , g_5 , and g_8 switches and capacitor C_3 will be in floating condition.

Mode 4:In this mode to get the output voltage as $3V_{dc}$, the charged capacitors C_1 and C_2 are connected in series with the input PV source by triggering the switches g_1 , g_2 , g_3 , g_8 , g_{10} , and g_{13} . Simultaneously, C_3 is charged to V_{dc} by turning on the g_5 & g_9 switches.

Mode 5: To achieve +4V_{dc} output voltage level, capacitors (C₁, C₂, and C₃) are connected in series to the input PV source by triggering g1, g2, g3, g4, g9, g10, and g13 switches.

Negative Voltage Levels

Mode 1: For obtain - V_{dc} output voltage g5, g9, g11, and g12 switches are triggered. At the same time, g1, g2, g3, and g8 switches are turned on to charge capacitor C3 during this time capacitors C3 and C1 in floating mode.

Mode 2: In this state g_4 , g_5 , g_8 , g_{11} , and g_{12} switches are triggered and to yield - $2V_{dc}$ output voltage capacitor C_3 connected cascaded to the input PV source. During this case, capacitor C_2 charges to V_{dc} by turning on g_1 , g_2 , and g_7 switches and capacitor C_1 is in floating mode.

Mode 3:In this mode g_3 , g_4 , g_5 , g_7 , g_{11} , and g_{12} are triggered, and capacitors C_2 and C_3 in series input PV source to get - $2V_{dc}$ output voltage level. Same time, C_1 is charged by turning on the g_1 , and g_6 switches.

Mode 4:For-4Vdc output voltage level, the switches g_2 , g_3 , g_4 , g_5 , g_6 , g_{11} , and g_{12} are turned on so C_1 , C_2 and C_3 in series with the PV source.

Level Shifted Pulse width modulation (LS-PWM)

Level-Shift Pulse Width Modulation (LS-PWM) is a modulation technique used in power electronic systems to generate variable-width pulse signals that control the switching of semiconductor devices (typically power transistors or IGBTs) in voltage source inverters, converters, and other switching applications. It's primarily employed in applications like motor drives, uninterruptible power supplies (UPS), and power factor correction systems. LS-PWM is designed to reduce voltage stresses on the switching devices and improve overall efficiency.





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Traditional Pulse Width Modulation (PWM) involves switching the high-side and low-side switches of a voltage source inverter alternately to generate an AC waveform with variable voltage and frequency.

Simulation Results

The MATLAB circuit diagram of the proposed PV-based 9-level MLI is shown in Fig.3 below. The performance of the proposed PV-based 9-level MLI converted is assessed in different conditions.

Case 1 Constant PV source and balanced load

In this scenario, a balanced RL load of 100 ohms and 120mH is connected to the power system network. The MATLAB circuit diagram of the proposed PV-based 9 levels MLI with balanced load is configured in Fig.3.

The simulation responses under this condition, such as output voltage, load current, and each capacitor voltage are shown in Fig. 3 (a), fig.3 (b), Fig. 3 (c) and Fig (d) respectively. PV produces a constant voltage of 100V and each capacitor charges up to 100V so from output voltage response it is confirmed that the proposed method provides balanced nine level output voltages. From the total harmonic distortion (THD) of the load voltage, it is clear that the harmonic content in the output voltage is 14%.

Case 2Constant PV source and unbalanced load

In this scenario, an unbalanced load is connected to the power system network. The MATLAB circuit diagram of the proposed PV-based 9 levels MLI with balanced load is configured in Fig.4. The simulation responses under this condition, such as output voltage, load current, and each capacitor voltage are shown in Fig. 4 (a) and respectively fig.4 (b), In this unbalanced load is considered as no load, 50-ohm resistive load, and 50 ohms plus 100mH inductive during different time sequences. Even for the unbalanced load condition also the proposed possesses the stable 400V as the nine-level voltage levels.

CONCLUSIONS

A switch capacitor technique based nine nine-levelquadruple MLI for small-scale solar PV systems is presented in this paper. The proposed SCMLI converter provides better transient free nine-level output voltage levels for constant input source and balanced load, constant input source and balanced load, and even for variable input source and constant load operating conditions also. The harmonic content of the output voltage is also of considerable value. For an efficient operation of SCMLI switches level shifting PWM technique is adopted over the popular traditional PWM techniques.

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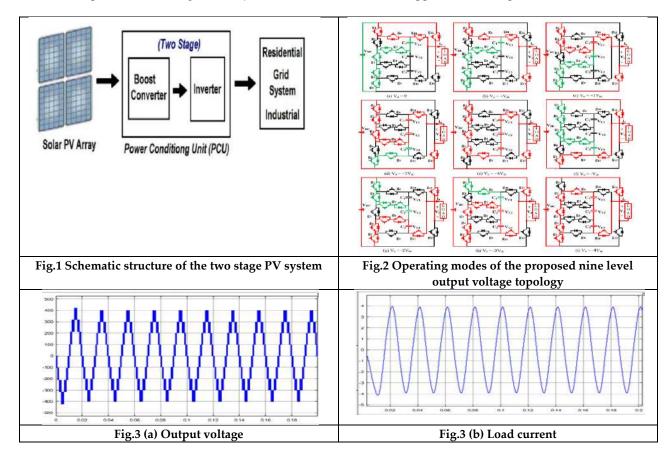
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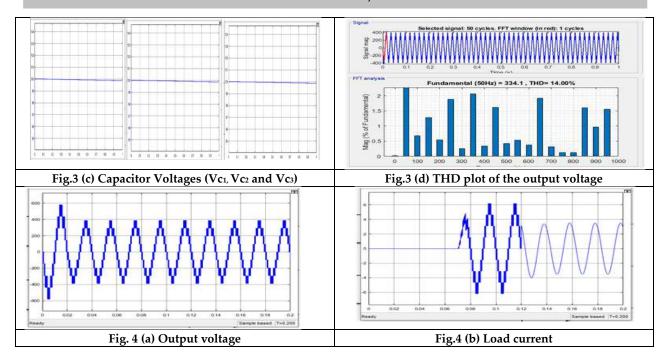
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RESEARCH ARTICLE

Effect of Heat Treatment on Physicochemical and Drug Release **Properties of Soluble Starch**

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ABSTRACT

The present study discusses the effect of thermal treatment on the physicochemical and drug-release properties of soluble potato starch. Starch has been a very versatile excipient used in industries over the years. But native starches suffer from certain drawbacks like poor compressibility, and low flow ability values. So, this study emphasizes on thermal modification of starch and its positive effect on drug release properties. Soluble starches were modified in two ways by heat treatment (Dry heat and Retrogradation) to study their potential use as an adjuvant in various drug delivery systems. The modification was carried out by continuous heating at 100°C for 3h while retrogradation was performed by making a suspension of starch and heating it for 2h at 60 °C to get a spongy solution which was further dried at 50°C to complete the process. The physicochemical properties were evaluated by swelling, solubility, flow property, amylose content, and water-holding properties as well as instrumental methods like XRD, and FESEM while in vitro dissolution was conducted for evaluating drug release. The retrogradation modification of starches enhanced all the physicochemical properties including swelling, solubility, flow property, amylose content, and water-holding properties. The FESEM studies and X-ray diffractograms indicated similar trends of enhancement in the case of retrograded starch samples. In vitro, dissolution studies conducted on tablets prepared using the native and modified starches indicated the tablet with retrograded starch was significantly delayed releasing as compared to other tablets. Thus this indicates the use of retrograded starch as an excipient in various delayed-releasing drug deliveries.

Keywords: Soluble starch, heat treatment, physicochemical properties, retrogradation, dry heat treatment





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INTRODUCTION

Starch is a very significant and widely dispersed natural substance that can be found in the leaves of green plants, seeds, fruits, stems, roots, and tubers and is an integral part offood [1]. It is the main source of energy for all life on Earth and acts as the molecular form of the sun's energy. Amylose and amylopectin, are two types of polysaccharides that are exclusively made of D-glucose residues with α -(1 \rightarrow 4) linkages in linear amylose and α -(1 \rightarrow 4) linkages and ~5% α -(1 \rightarrow 6) branch linkages in amylopectin, are combined to form a water-insoluble, partially crystalline granule whose size, shape, and morphology depend on its biological source[2,3]. Starch in its native or natural form, finds its wide usage in various industries including food and pharmaceutical industries. Native starch, despite its enormous commercial value, has certain inherent disadvantages when it comes to pharmaceutical application, which include, poor compressibility, low flow ability values, and frequent issues with drug/excipient compatibility[4]. So, to combat this, modifications of starch are necessary for its optimum usage in industry. There are various methods by which modifications can be performed like oxidization, hydroxylation, acetylation, and citritation to improve its functional characteristics, but it distorts the starch granules which may lead to toxicity[5]. Due to this problem of toxicity, new research has leaned towards natural modifications like heat treatment of different native or physically modified starches. Various studies have shown that heat treatment methods like retrogradation, and pregelatinization[6] help to improve gel and film-forming properties[7], sustained release drug delivery[8] as well as film forming properties[9]. Thus this study explores the effect of heat treatments (dry heat treatment and retrogradation of starch) on their physicochemical properties and recognizes the enhanced effect of these heat-modified starches in oral novel delayed-release drug delivery applications.

MATERIAL AND METHODS

MATERIALS

The soluble maize starch was procured from Nice Chemicals Pvt Ltd. All the other chemicals and solvents used throughout the study were of analytical grade obtained from. The solutions were prepared in distilled water.

METHODS

Modification of starch

Dry heat modification

The dry heat treatment was prepared as per the methods reported by Liu *et al.*, (2021)[10]with slight modifications.10 g of native starch (NS)was taken on an open petri dish and continuously heated at 100 °C in a hot air oven (Globe Instruments, India) for a period of 3h and then cooled at room temperature to get DHS. The DHS sample was stored in an airtight container.

Retrogradation of starch

The retrograded starch was prepared according to the method mentioned by Jayaram et al., 2021 [11]with slight modifications. 25% w/v native starch solution was heated for a period of 2h at 60 °C in a hot air oven (Globe Instruments, India) and then the sample was cooled at room temperature to give a spongy suspension. The spongy suspension occurred due to the process of heating helps in the transition of the nematic order of starch to an amorphous state[12]. The sample (RGS) was dried at 50 °C for 24h in a hot air oven (Globe Instruments, India) and stored in an airtight container.

Physicochemical properties of starch Micromeritic properties

Bulk and tapped densities

2g of NS, DHS, and RGS samples were placed in a 5 mL measuring cylinder and the occupied volume is noted as bulk volume. Then the measuring cylinder was tapped 50 times on a plain surface from the height of 2 inches at an





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interval of 2s and then the tapped volume was measured. The bulk and tapped volume were measured by the following formula[13].

$$Bulk\ Density = \frac{\text{Mass of Powder}}{\text{Bulk Volume}} \tag{1}$$

$$Tapped Density = \frac{\text{Bulk Volume}}{\text{Tapped volume}}$$

$$(1)$$

$$(2)$$

Compressibility index

The compressibility of the native and heat-treated starches was calculated through Carr's index and Hausner's ratio using the following formulas [13]

$$Carr's Index = \frac{\rho_{tapped} - \rho_{bulk}}{\rho_{tapped}} \times 100$$

$$Hausner's ratio = \frac{\rho_{tapped}}{\rho_{bulk}} \times 100$$
(4)

$$Hausner's \ ratio = \frac{\rho_{tapped}}{\rho_{tapped}}$$
 (4)

Angle of Repose

The fixed funnel method was used to calculate the angle of repose. A funnel was secured to a stand. Weighing 10 g starch samples, they were gradually moved through the funnel until the peak of the heap touched the tip of the funnel. The angle of repose was measured by measuring the height of the starch sample heap (h) and dividing the mean diameter (d) of the base in half. The angle of repose for each sample was calculated using the provided formula[14].

$$\theta = \tan^{-1}\left(\frac{h}{r}\right) \tag{5}$$

Moisture content

1g each of NS, DHS, and RGS were transferred to a clean petri dish. They were then dried in a hot air oven for 2h at 100 °C in a hot air oven (Globe Instruments, India) until a constant weight was achieved. The calculation of moisture content was done as a percentage loss in weight[15].

Swelling and Solubility

Native and modified starch (1% w/v) suspensions were produced and cooked for 30 minutes at 30° to 90° C with continual agitation in a temperature-controlled water bath. The materials were centrifuged for 15 minutes at 3000 rpm (Remi R303, Remi, India). The supernatant was drained off, and the adherent residue (Wss) was weighed. It was dried (W_{su}) for 6 hours at constant weight in a hot air oven at 60 °C[16]. Solubility and swelling percentages were calculated by using the equation,

% Solubility =
$$\binom{W_{Su}}{W_i} \times 100(6)$$

% Swelling = $\left(\frac{W_{SS}}{W_i \times (100 - \% solubility)}\right) \times 100 (7)$

Water holding capacity

Water holding capacity was calculated by dissolving 0.1 g of NS, DHS, and RGS in 10 mL of distilled water and stirring for 1 hour. The resulting solution was put into a centrifuge tube. After that, it was centrifuged for 10 minutes at 3000 rpm (Remi R303, Remi, India). After discarding the supernatant, precipitated starch samples were weighed. Water holding capacity was determined by the following formula[17].

$$WHC(\%) = \left(\frac{W_S}{W}\right) \times 100(8)$$

Amylose content

The iodometric method was used to determine the amylose content in native and modified starches. The amylose content of native and modified starches was determined using the iodometric technique. Each starch sample (NS, DHS, and RGS) was obtained in 100 mg increments for dispersion in 1 mL of (95% w/v) ethanol and 9mL of 0.1N NaOH. The samples were heated in a water bath for 10 min. The solutions were then allowed to cool at room





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temperature before being diluted to 100 mL with distilled water. 1 mL glacial acetic acid and 2 mL iodine were mixed with 5 mL of the aforesaid solution and diluted to 100 mL with distilled water. The absorbance of each sample was measured in the UV spectrophotometer (Shimadzu 1900, Japan) against its respective blank at 620 nm[18]. The amylose content can be calculated by the following formula.

% Amylose = $3.06*\times$ Absorbance \times 20

(9)

*3.06 is the conversion factor

Fourier Transform Infrared Spectroscopy (FTIR)

The FTIR spectrum of all samples was recorded using Alpha II (Bruker, Germany) between frequency ranges of 400–4000 cm⁻¹. Dried KBr was mixed with starch blend samples for determination[19].

Field emission scanning electron microscope (FESEM)

Field emission scanning electron microscopy (Germany's Zeiss Gemini 300) was used to analyze the morphology of natural and modified starch. Dry starch samples were mounted on a circle of aluminum tubing using double-sided carbon adhesive tape, and then a thin gold layer was applied. At 110 kV accelerating voltage, images were captured at magnifications between 200X and 500 X[20].

X-ray diffraction (XRD)

The crystalline characteristics of the dried, moisture-free samples were assessed using an X-ray diffractometer (Smart Lab, Rigaku, Japan). The diffraction angles (2) between 2 and 80° at 1° /min were used with the apparatus, which was run at 30 mA and 40 kV[20].

Formulation and in vitro dissolution of the tablet

Granules prepared by wet granulation method using Paracetamol as a model drug. Other excipients like Lactose, and Gum Acacia, along with sample starches were mixed individually as per Table 1 and a wet mass was prepared by the addition of distilled water dropwise. The wet masses were granulated by passing them through an ASTM # 12 sieve. The granules were dried at 50 °C for 30 min and passed through an ASTM # 16 sieve. Finally, Talc and Magnesium Stearate were added and tablets were compressed using a Kambert 8-station tablet punching machine. The dissolution study was performed in 900ml phosphate buffer at pH 6.8 with a temperature condition of 37 ± 5 °C using 8 stations USP Type II apparatus (Lab India DS8000) with a paddle rotating at 50 rpm. Three tablet formulations with NS (F1), DHS (F2), and RGS (F3) of 650 mg each were placed in a dissolution basket. At fixed interval, samples were withdrawn, filtered, and checked spectrophotometrically at 268 nm. The rate of drug release at different time intervals was calculated[8].

Statistical analysis

All the data reported are an average of triplicate observations. The data were expressed as means ± standard deviation

RESULTS

Micromeritic studies

The micromeritic properties shed light on the arrangement and packing of the particles and the compaction profile of a material. The Carr's index and Hausner's ratio of DHS and RGS were in the ranges of 15.95 ± 0.05 - 21.20 ± 0.03 and 1.186 ± 0.10 - 1.263 ± 0.21 respectively compared to the values of native starch (Table 2) indicating the flow improved significantly from poor flow to good flow with heat treatment especially retrogradation can majorly improve micromeritic properties of starch. The angle of repose also shows a similar kind of trend especially with the RGS sample. Thus this flow property will potentially lead to the development of extended drug delivery[21].





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Moisture content

The moisture content (Table 2) of the starches ranged between 9.03±0.12%-15.35±0.08% for all samples which were within the range specified in Indian Pharmacopoeia. The low moisture content helps them attain better flow properties and also helps in microencapsulation and drug fortification[22].

Water holding capacity

The water holding capacity (Table 3) of the heat-treated starches ranged between 103.05%±0.01-131.16%±0.02 as compared to NS having a water holding capacity of 98.13±0.02. The increase in the water-holding capacity due to heat treatment may be associated with the unfastened bonding of amylose and amylopectin due to heat treatment. This high water-holding capacity may find its application in gel or hydrogel formulations[23].

Amylose content

The amylose content for heat-treated starch showed (Table 2) a significant increasing trend. The DHS sample had an amylose content of 67.85±0.11% and RGS had 85.42±0.04% as compared to the NS sample having 58.67±0.08%. The increase in amylose content can result inbetter starch drug complexes indicating the potential use of the heat-treated starches in target-specific drug delivery systems[24].

Swelling and solubility

The swelling and solubility data of the starch samples are shown in Tables 4 and 5. The increase in % swelling and solubility can be observed for heat-treated starches as compared to the native starch samples. The swelling power for the NS sample ranged from 3.23 ± 0.35 - 9.12 ± 0.22 as compared to the heat-treated sample $(5.57 \pm 0.45$ - $11.33 \pm 0.28)$ while for % solubility the heat-treated starches ranged from 78.46 ± 0.45 - 96.33 ± 0.28 as compared to the range of native sample $(68.33 \pm 0.35$ - $79.12 \pm 0.22)$. The variation in swelling is generally attributed to its water-holding capacity and crystallinity. The increased swelling and solubility can be useful in the formulation of gastroretentive drug delivery[25].

FTIR spectroscopy

All native and modified starch samples were assessed using FT-IR for the determination of the chemical changes due to modifications. The obtained data are graphically represented in Fig. 1. A wide band at 3315 (NS and DHS) and 3278 (RGS) cm ⁻¹ in case of the samples were observed might be attributed to -OH bond stretching while, a sharp peak near 3000 cm ⁻¹ for all three samples indicating the presence of -CH stretching. This indicated no chemical changes were observed due to the heat treatment of the starch[26].

Morphological study

Under 200 × magnification, the scanning electron microgram of NS, DHS, and RGS in Figure 2. The microgram of NS shows a plain surface with some little aggregation, while DHS has multiple ridge-like aggregates. The ridge-like aggregates increase much more in retrograded starch (RGS). The irregularly shaped particles indicate that it is amorphous. The crevices on the surface of RGS aid in drug entrapment and delayed release of drugs[27] (Elella *et al.*, 2022).

X-ray pattern

Figure. 3 shows the XRD patterns of NS, DHS, and RGS. In contrast to the modified RGS and DHS starches, it was discovered that the native NS starch is non-amorphous. The NS starch showed intense scattering peaks located at 32° , 46.5° and 57° 20 demonstrating the crystalline nature of the starch. DHS and RGS's amorphous character was indicated by the lack of any notable scattering peaks in their diffraction patterns. Thus, the breaking of the double helix and the reduction in crystalline amylopectin regions are shown by a decrease in the strength of crystalline peaks in heat-treated starches [28].





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In vitro dissolution study

The *in vitro* dissolution study of tablets prepared using native (F1), dry heated (F2) and retrograded starches (F3) are shown in Fig. 4. The F1 formulation (97.88%) showed fast-releasing characteristics compared to F2 (89.58%) and F3 (75.32%) after 6 hours of dissolution study indicating F3 to show significant delayed releasing property. This may be due to the formation of a gelatinous barrier of pregelatinized starch present in a tablet formulation F3 caused by the retrogradation process[29].

DISCUSSIONS

Starch is an abundant material found in nature that forms an integral part of food as the main source of carbohydrates. Starch is regarded as safe (GRAS) due to its usage as food and finds its usage in different industries including the pharmaceutical industry as an excipient[30]. Natural starches suffer multiple problems including poor compressibility, low flow ability values, and frequent issues with drug/excipient compatibility. So to combat this very problem as well as improve the properties of starch for providing usage in multiple drug deliveries various modifications can be performed. One of the modes of modification is the thermal treatment of starches. In this study, commercial soluble starch samples were thermally modified in two ways that are by dry heat treatment and retrogradation. Dry heat modification was performed by heating the native starch sample (NS) at 100 °C in a hot air oven to get DHS samples while retrogradation was performed on NS for a period of 2h at 60 °C and then the sample was cooled at room temperature to give a spongy suspension. The sample (RGS) was dried at 50 °C for 24h[11, 31]. FTIR studies indicated that there was no chemical change in any of the modified samples of starch. The two modified samples were tested for their physicochemical properties and compared with native starches to determine the improvement in properties and their enhanced usage in multiple drug deliveries. Micromeritic studies showed that the modified samples especially RGS had a significant improvement in the flow properties thereby influencing the compression characteristics of starch granules which can be explored for the development of an extended-release drug delivery [32]. The moisture content of all the samples was well within IP guidelines and these low moisture content of starch, signals for drug fortification and gastro-retention of hygroscopic drugs, indicating its usage in novel drug deliveries targeting intestinal pH[33]. The water-holding capacity of the native and modified starch showed enhancement of water-holding properties in the retrograded starch sample, which therefore can find its usage in the formulation of stable hydrogel with higher entrapment of water and minimized evaporation[34].

A similar trend is observed in the case of amylose content where RGS (131.16±0.02 %) had the highest value as compared to NS (98.13±0.02 %) and even DHS. Thus this higher amylose contentcan result in a better starch drug complex indicating the potential use of heat-treated starches in target-specific drug delivery systems [24]. The solubility power was shown to increase with temperature with the highest solubility observed in RGS (86.53 ± 0.42-96.33 ± 0.28 %). This phenomenon can be attributed to the fact that with an increase in temperature, molecular mobility in starch also increases along with the solubility but also makes the sample suitable for delayed targeted drug delivery systems [35]. The modified starches showed to become amorphous due to heat treatment indicating a decrease in crystalline amylopectins. The SEM studies show that retrograded samples, RGS have maximum ridges which can help in drug entrapment and delay the release of drugs[33]. Tablets prepared using the three starch samples and their *in vitro* dissolution study revealed that the tablet with RGS had shown significantly delayed release of the drug[27, 36]. Hence from all the physicochemical properties of the three samples and *in vitro* studies on their tablets, it can be identified that RGS starch (75.32% release after 6h) shows major improvement as compared to the native starch (97.88% release) and can be used in the development of multiple drug delivery systems.

CONCLUSIONS

The present work reveals a novel excipient with thermal treatment (dry heat and retrogradation) of soluble starch. The enhancement in all the physicochemical properties including Amylose content(85.557±0.08 [NS] to 105.325±0.04[RGS]), and moisture content were noticed due to the heat treatment. The swelling and solubility were





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also found to increase with the heat treatment of starches indicating its potential as an adjuvant in gastroprotective delayed releasing drug delivery. The amorphous nature of the modified starches and the FESEM micrographs showed maximum ridges on RGS indicating entrapment of drug on the excipient surface. The *in vitro* studies on tablets prepared using all three samples of starch showed significantly delayed drug release in the case of RGS-based tablets. The enhanced physicochemical properties of RGS indicate its usage inoral delayed drug delivery systems. Thus in conclusion it can be said that retrograde modification of the starch has enhanced its properties thereby making it fit for usage in various drug deliveries.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest whatsoever.

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Table 1: Formulation design of Paracetamol tablet using native and modified starch

Ingredients	F1	F2	F3
Paracetamol	68	68	68
NS	10	ı	-
DHS	-	10	-
RGS	-	-	10
Lactose	5	5	5
Gum Acacia	5	5	5
Talc	1	1	1
Magnesium Stearate	1	1	1

Table 2: Micromeritic properties of native and heat treated starches

Sl. No.	Micromeritic Study	NS	DHS	RGS
1.	Bulk Density (g/cc)	0.542 ±0.03	0.561 ±0.13	0.711 ±0.04
2.	Tapped Density (g/cc)	0.833 ± 0.11	0.712 ±0.09	0.846 ±0.06
3.	Hausner's ratio	1.536 ±0.36	1.263 ± 0.21	1.186 ±0.10
4.	Carr's index	34.93 ±0.06	21.20 ±0.03	15.95 ±0.05
5.	Angle of Repose (°)	46.73 ±0.19	42.76 ±0.22	35.09 ±0.08

Table 3: Physicochemical properties of native and heat-treated starches

Sl. No.	Physicochemical Evaluation	NS	DHS	RGS
1.	Moisture content (%)	12.91±0.06	9.03±0.12	15.35±0.08
2.	Water holding capacity (%)	98.13±0.02	103.05±0.01	131.16±0.02
3.	Amylose content (%)	58.67±0.08	67.85±0.11	85.42±0.04

Table 4: Swelling power of native and heat treated starches

Table 4. 5 Weining power of native and near treated statenes					
Sample		Swelling Power (%)			
	30°C	40°C	50°C	60°C	
NS (Native starch)	3.23 ± 0.35	4.57 ± 0.18	5.89 ± 0.82	9.12 ± 0.22	
DHS (Dry heat treated starch)	5.57 ± 0.45	7.53 ± 0.22	8.22 ± 0.41	10.13 ± 0.29	
RGS (Retrograded starch)	6.53 ± 0.42	8.86 ± 0.35	9.24 ± 0.22	11.33 ± 0.28	

Table 5: Solubility power of native and heat-treated starches

Sample		Solubility (%)			
	30°C	40°C	50°C	60°C	
NS (Native starch)	68.33 ± 0.35	72.38 ± 0.18	77.89 ± 0.82	79.12 ± 0.22	
DHS (Dry heat treated starch)	78.46 ± 0.45	83.53 ± 0.22	86.22 ± 0.41	87.13 ± 0.29	
RGS (Retrograded starch)	86.53 ± 0.42	89.86 ± 0.35	93.24 ± 0.22	96.33 ± 0.28	





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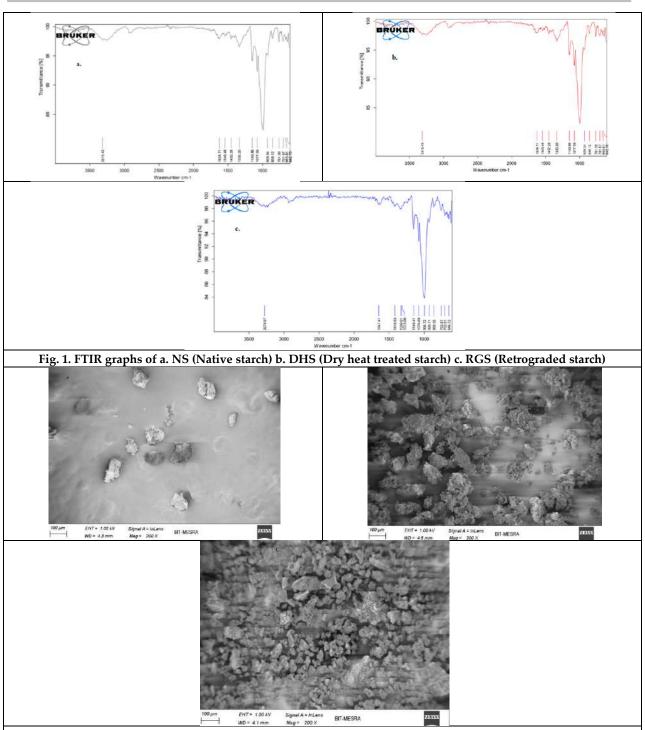
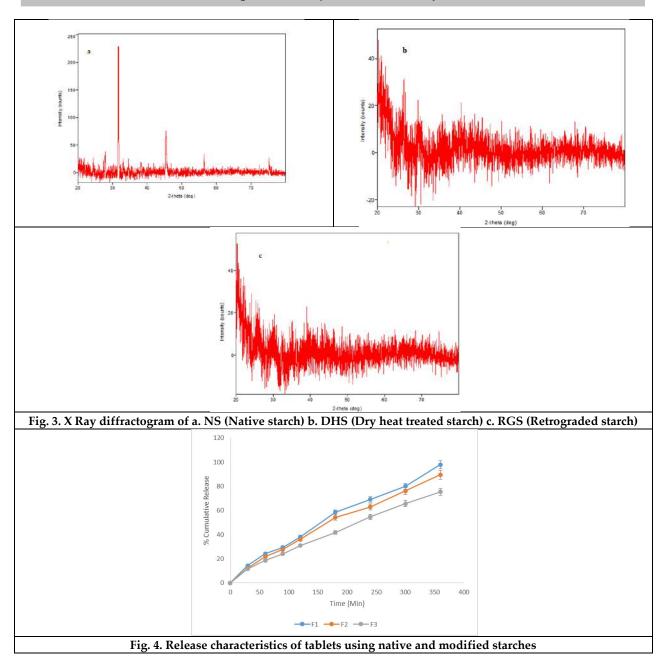


Fig. 2. FESEM micrograms (200x) of a. NS (Native starch) b. DHS (Dry heat treated starch) c. RGS (Retrograded starch)





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REVIEW ARTICLE

A Statistical Review of the Environmental and Social Impacts of Climate Change in the Indian Context

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ABSTRACT

Climate change is one of the biggest challenges faced by humanity across the world today. The consequences of climate change have turned out to be a reality and its impacts on all countries are unpredictable and significant. India is highly vulnerable to climatic changes, as it is thronged with planes, hills, mountains and surrounded by seacoast, and steep gradients. Since climate change and variability have badly and drastically hit the various regional sectors of India with irregular floods, drought, hurricanes and cyclones, climatic fluctuation has grown into a major concern and worry for the people of India. The present study analyzes the impacts and variability of climate change especially, of India in comparison to other developed and underdeveloped countries, and to what extent these climatic fluctuations influence the environmental and social life of the people of the country. Conducting such a study on climate change based on analysis of data collected will bolster us to depict the real situation of climate change in India. Secondary data on climate change and its related variables over the years is used for analysis. A time series study and cointegration techniques are used to establish the relationship between the environmental and social implications of climate change that has a colossal influence on the life of the Indian people. The findings and recommendations of the study will be reported based on the analysis conducted.





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Keywords: Climate change, Social aspect, Environmental aspect, Climate variables

INTRODUCTION

Climate change - a long-term shift in global weather patterns, primarily caused by human activities, is a pressing issue that affects the entire planet and all its inhabitants. The increase in atmospheric concentrations of greenhouse gases (such as carbon dioxide) traps more heat from the sun and raises global temperatures. As global temperatures continue to rise, extreme weather events such as hurricanes, heat waves, and droughts are becoming more frequent and intense, leading to the loss of biodiversity. It is crucial that we take action to mitigate the impacts of climate change and work towards a more sustainable and resilient future for all. Climate change is not just an environmental issue, it is also a social issue that has far-reaching impacts on people and communities around the world. The social and environmental impacts of climate change are complex and interrelated, and they affect different populations in different ways. India is one of the most vulnerable countries to the impacts of climate change, due to its large population, high poverty levels, and limited capacity to adapt. The social life of the people of India is already being significantly impacted by the effects of climate change. One major impact is that it leads to more frequent droughts and erratic rainfall patterns, which are reducing the yields of crops and causing food shortages. This is particularly devastating for poor and rural communities that rely on agriculture for their livelihoods and leading to increased environmental, social, and economic pressures. Another impact of climate change on social life in India is the occurrence of heat waves and floods, which are becoming more frequent and intense. So, it is high time to tackle climate change which requires a coordinated effort by governments, civil society organizations, and individuals, to reduce greenhouse gas emissions, enhance adaptive capacities, and promote sustainable development.

This article studies the science of climate change and its consequences on human life in India. Also, it evaluates how the environmental and social life of the people of India is affected and distorted by climatic variation based on the analysis of the secondary data. The science of climate change and the influence it brings on temperature, precipitation, forest, sea level and the health sector of India are well illustrated (Balasubramanian, 2012). (Kumar, 2011) made an attempt to study the different disasters and natural calamities that took place in India as a result of climate change. The impact of climate change made by the transportation sector mainly due to greenhouse gas emissions are well recorded (Ogola, 2022). (Yang et al., 2022) pointed out the usefulness of the circular economy for meeting the targets for preventing climate change and regenerating the equilibrium of the ecosystem. (Bhattacharya & Sachdev, 2021) studied how climate change has become a pressing issue among Indian people and how to overcome such issues in the future. (Khanna et al., 2022) portrays the concept of circular economy and how it can be a mitigation policy for tackling climate change and its disastrous impact. A research report by the national intelligence council (National Intelligence Council, 2009) foretells the impact that can be made by climate change by the year 2030 in India in the light of the observed changes. Thus the present study will evaluate the notion of climate change and its background in India. It also evaluates the factors affecting climate change in India in comparison with other developed and underdeveloped countries and also analyzes the impact of climate change on the environmental and social life of the people of India.

METHODOLOGY

This paper is both empirical and descriptive in nature. The data was collected from secondary sources such as journals, articles, and government reports. The data used for comparison of climate change in India with that of different developed and underdeveloped countries is taken from the source of 'Our World in Data' based on the Global Carbon Project (2021). 'Our World in Data' is a project of the global change data lab, which is a registered charity in England and Wales. All the analysis done in this paper is based on those data for comparing climate change in India with that of other countries. The year of data varies according to various topics. Still, the data covers a span of more than 25 years to do the comparison.





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The Concept of Climate Change and its Impacts

Climate change that affects the entire planet and all its inhabitants is caused by a combination of natural and human factors, with the primary cause being the increased concentration of greenhouse gases, such as carbon dioxide, in the atmosphere. These gases produce heat from the sun, causing the Earth's temperature to rise and leading to uneven climatic variations. Climate change, according to the United Nations Framework Convention on Climate Change (UNFCCC), is "a change in climate that is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and that is in addition to natural climate variation observed over comparable time periods". Therefore, the current warming trend is, however, overwhelmingly believed to be primarily the result of human activity, according to the research world. The effects of climate change are extensive and profound which include rising sea levels, melting of glaciers and ice sheets, more frequent and intense weather change, such as cyclones, heatwaves, droughts, and changes in ecosystem. Climate change is also having a major impact on human health, food security, and economic development, especially in developing countries. The impacts of climate change are already being felt and will only become more severe unless we take action to address its causes and mitigate its consequences.

Background of Climate Variation in India

The history of climate change in India can be traced back to the late 19th and early 20th centuries when evidence of rising temperatures and changes in precipitation patterns began to emerge. In the mid-20th century, India saw increased environmental degradation due to increased industrialization and population growth, which led to increased greenhouse gas emissions and deforestation. In the 1980s and 1990s, India became more actively involved in the international dialogue on climate change and joined the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. Since then, India has been an active participant in international climate change negotiations and has taken several measures to reduce its greenhouse gas emissions and mitigate the impacts of climate change. One of the early efforts to study the impacts of climate change in India was the National Action Plan on Climate Change (NAPCC), which was launched in 2008. The NAPCC outlined a thorough strategy for combating climate change, including mitigation tactics to lower greenhouse gas emissions as well as adaptation plans to deal with its effects. Over the years, there have been numerous studies on the impacts of climate change in India, including assessments of the impacts on agriculture, water resources, coastal zones, and human health. While much work remains to be done, the progress that has been made over the past few decades provides the reason for optimism that India will continue to play a leading role in addressing climate change in the years to come.

Factors affecting Climate Change in India

The complex phenomena of climate change are the consequence of the interaction of numerous natural and human forces, and it has a significant impact on both the environment and human existence. Some of the key factors affecting climate change and their impacts are the following.

Greenhouse gases

The major factor affecting climate change is the increase in greenhouse gases in the atmosphere. Greenhouse gases, such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), trap heat from the sun in the atmosphere and prevent it from escaping into space. This is known as the greenhouse effect, and it is what keeps the earth warm enough to support life. However, the burning of fossil fuels such as coal, oil, and natural gas releases large amounts of CO₂ into the atmosphere, increasing its concentration and enhancing the acuteness of the greenhouse effect which is harmful to life on earth. In India, greenhouse gases are generated from a variety of sources, including energy production, transportation, agriculture, and industrial processes. The graph (figure.1) indicates that there is an upward trend in the emission of greenhouse gas in India. Though there is a decline in the year 2019, the graph is still ascending in the following years of 2020 and 2021. Hence the trend is rising upward which is not healthy for a developing nation like India. It is evident from the graph (figure.2) that India is far better in the emission of greenhouse gas compared to the developed nations.





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Deforestation

Another factor causing climate change in India is deforestation. Trees absorb CO_2 from the atmosphere and store it as carbon in their wood and leaves. Deforestation reduces the number of trees available to absorb CO_2 , leading to a rise in atmospheric CO_2 levels and an increase in global temperatures. Deforestation in India is primarily driven by agricultural expansion, urbanization, and infrastructure development. Illegal logging and mining activities also contribute to deforestation in some areas. Figure 4 shows the tree cover loss due to deforestation and an equivalent CO_2 emission. The graph portrays a cointegration time series in tree cover loss and CO_2 emission. That means they move exactly together which points by the tree cover loss an equal proportion of CO_2 is emitted into the atmosphere. Cointegration analysis is a statistical method for examining the relationship between two or more non-stationary time series variables. The result of the cointegration analysis (table 1) bolsters the assumption that there is significant equal proportion of tree loss and CO_2 emission. Because the p-value is less than .05 which shows a strong cointegration of the two.

Changing pattern of land use

Primarily to expand agricultural land, humans alter the land's surface which contributes to climate change. Land use changes can alter the amount of carbon stored in the soil, leading to the emission of CO₂ and a rise in global temperatures. Additionally, the use of fertilizers and other chemicals in agriculture can release nitrous oxide, a potent greenhouse gas, into the atmosphere. That ignites climate variations. According to the report by the Indian Space Research Organization, approximately 29% of India's land area is affected by land degradation, including soil erosion, desertification, and deforestation.

Transportation and Industrialization

India's climate change has been significantly impacted by transportation and industrialization. Industry expansion and a sharp rise in the number of automobiles on the road have resulted fuels for climate change. The burning of fossil fuels for transportation releases large amounts of CO₂ into the atmosphere, while industrial processes such as cement production and the burning of waste also release a significant amount of greenhouse gases. Air pollution which has a direct effect on the climate is another consequence of industrialization and transportation, that causes a decrease in the amount of sunlight that reaches the Earth's surface, which can lead to a cooling effect in the short term, but it can also contribute to global warming in the long run.

Environmental Impacts of Climate Change in India

Rising temperatures

Over the past few decades, India has experienced a considerable increase in temperature. Since the turn of the 20th century, India's average temperature has risen by about 0.7°C, with the majority of the warming taking place in the most recent few decades. In recent years, many parts of the country have experienced record-breaking temperatures, with some of the northern states reaching as high as 50°C. Higher temperatures lead to increased evaporation and precipitation, which can lead to frequent droughts and floods.

Rising sea levels

In India, sea level rise has been particularly pronounced on the east coast and the Andaman and Nicobar Islands, where sea levels have risen by up to 4 millimeters per year in some areas. Rising sea levels have led to increased coastal erosion in many parts of India, particularly in areas lacking natural protection, such as dunes or mangroves. Coastal erosion has resulted in the loss of land and infrastructure, as well as an increased risk of flooding and other natural disasters. India's major coastal cities, such as Mumbai, Kolkata, and Chennai, are at risk of severe damage from sea level rise, as well as increased frequency and severity of coastal flooding.





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Changes in ecosystems

The impacts of climate change are being felt in ecosystems across India. Changes in precipitation patterns and increased frequency of extreme weather events are affecting ecosystems and species in India, including forests, wetlands, and grasslands. Climate change is striking the distribution and behavior of wildlife species in India, including changes in migration patterns and declines in populations of some species which can disrupt ecosystems and lead to declines in biodiversity.

Extreme weather events

Extreme weather events become more often and more intense in India because of climate change, having a substantial influence on the nation's infrastructure, economy, and population. India has experienced an increase in the frequency of extreme heat events in recent decades, with heat waves becoming more intense and lasting longer. The frequency of tropical cyclones in the Bay of Bengal and the Arabian Sea is also increasing, with severe storms leading to increased damage to infrastructure, loss of life, and displacement of populations.

Social Impacts of Climate Change in India

In India, climate change is posing a series of concerns for people's social and environmental well-being, with detrimental effects on health, livelihoods, and economic stability. Some of the key challenges posed by climate change on the social well-being in India include:

Health impacts

Climate change is affecting public health in India, with frequent drought, flooding, and air pollution leading to increased morbidity and mortality. Climate change is exacerbating air pollution in India, leading to increased levels of fine particulate matter and other pollutants, which have been linked to respiratory and cardiovascular diseases, as well as premature death. As, climate change is affecting water resources in India, leading to water scarcity and water quality problems, which can increase the risk of water-borne diseases, such as cholera and diarrhea.

Food security, livelihoods, and poverty

Due to the change in weather pattern, agricultural yields are declining to a great extent and that causes the food security of the people of India. The supply of water in India is growing unpredictably due to the shifting environment. There is a shortage of water in numerous areas as a result of glacier melting and altered monsoon patterns. Hence, the varying climate situations affect livelihoods and contribute to poverty in India, particularly among communities that rely on agriculture, fisheries, and other natural resources.

Displacement and migration

The majority of people of India rely on agriculture, fisheries, and other natural resources for their livelihood and existence. Due to extreme weather events, declining crop yields, reduced availability of water resources, and the loss of livelihoods are becoming usual in recent times which can lead to displacement and migration. That means thousands of people are being forced to leave their homes in search of safety and shelter due to unpredictable environmental factors.

Biodiversity loss

Climate change is a serious threat to biodiversity in India. The distribution and behavior of wildlife species are being impacted by changes in precipitation patterns and a rise in the frequency of extreme weather events. This poses the extinction of species that are unable to adapt to changing environmental conditions. Therefore, the loss of habitats becomes the primary driver of biodiversity loss in India. These challenges highlight the need for urgent action to address the causes and impacts of climate change in India, to alleviate nature distortions and protect the ecosystem.





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Climate change Mitigation (Recommendations)

Reduction in Greenhouse gas emission

Due to the burning of fossil fuels and changes in land use, CO₂ emissions are still rising. Fossil fuel supplies are plentiful and won't prevent the 21st century from having high carbon emissions. To forecast how future atmospheric concentrations of greenhouse gases might vary, emission scenarios can be used in conjunction with carbon cycle modeling. These combined models predict that the atmospheric CO₂ concentration by the year 2100 might range between 380 and 1400 ppm. Less rapid emission reductions beyond 2030 would be possible with tighter near-term emission reductions to keep the temperature below 2 °C.

Circular Economy

The circular economy can play an important role in mitigating the impacts of climate change. In a circular economy, resources are kept in use for as long as possible, and waste is minimized. This is achieved by designing products and materials that are durable, reusable, and recyclable, and by creating closed-loop systems that keep materials and resources in use. The circular economy can help to reduce the use of fossil fuels and the emissions associated with their extraction, production, and transportation. Figure. 5 demonstrates the cycle of a circular economy for the mitigation of climate change.

Adaptation

The process of modifying natural and human systems to deal with or react to the consequences of climate change is referred to as "climate change adaptation.". This entails developing strategies and implementing policies into place to the consequences of climate change on susceptible communities, the economy, and the environment. Adaptation can take many forms, ranging from building sea walls and strengthening infrastructure to withstand increased storms and flooding, developing drought-resistant crops, or shifting to different agricultural practices. In developing nations, like India, where the effects of global warming are expected to be most severe, adaptation is especially crucial.

Eco-Innovations

Eco-innovations are the concept of using technology to intervene in the Earth's climate system to counteract the effects of human-caused climate change. Eco-innovation can be a potential solution to the urgent problem of global warming and other climate variability issues. The points below can serve as a starting point for formulating climate policies and engineering.

Solar Energy

India has recently made significant investments in solar energy. This will facilitate the ultimate transition away from electrical generation based on fossil fuels. As of 2021, India had an installed solar capacity of 38.1 GW, making it one of the largest solar markets in the world. The country has set a target of achieving 100 GW of installed solar capacity by 2022, and 450 GW by 2030. According to the International Energy Agency, India is projected to become the third-largest solar market in the world by 2025, behind only China and the United States.

Waste management

There has been little progress in waste management in India. Hence, the nation in need of a distinct waste management policy mandate. The solution to this issue is the development of waste-selective management facilities, such as waste gasification. According to the Central Pollution Control Board, India generated about 261 million tons of municipal solid waste in 2019, with projections suggesting that this figure could reach 500 million tons by 2030. In 2019, only about half of the waste generated in India was collected, and only around 30% of the collected waste was treated or disposed of properly. The Indian government has taken several steps to improve the country's waste management practices, including the Swachh Bharat Abhiyan (Clean India Mission), which aims to clean up India's





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cities and rural areas, and the Solid Waste Management Rules, which provide guidelines for the collection, treatment, and disposal of waste.

Utilization of electric vehicles

Electric vehicles (EVs), the revolution in the transportation sector, use electricity stored in rechargeable batteries to power an electric motor, instead of relying on traditional fossil fuels like gasoline or diesel which influences climate change. By transitioning to EVs, countries can reduce their carbon footprint and improve air quality, which can have positive impacts on public health and a more sustainable energy system. The use of electric vehicles (EVs) in India is still in its early stages, but there has been some progress in recent years. According to a report by the Society of Manufacturers of Electric Vehicles (SMEV), India sold around 156,000 EVs in 2020-21, which is a 20% increase from the previous year. Further, the government has set a target of achieving 30% electric vehicle penetration by 2030, which would help to reduce greenhouse gas emissions from the transportation sector and mitigate the impacts of climate change.

Bioenergy

Bioenergy can play a role in mitigating climate change by reducing greenhouse gas emissions. When bioenergy crops or waste are burned, they release carbon dioxide into the atmosphere, but this is balanced out by the carbon dioxide absorbed by the next generation of crops as they grow. This is known as the carbon cycle, which means that bioenergy can be considered a carbon-neutral or even carbon-negative source of energy, depending on the specific feedstocks and production methods used. In addition to that, bioenergy can help to reduce carbon emissions by providing a renewable source of energy that can be used in place of fossil fuels, which release large amounts of carbon dioxide when burned. The below figure describes the generation of renewable energy sources by different countries in which India was at top of the graph in the beginning, but at present lies at the bottom showing that even underdeveloped countries are better than India.

Reforestation

To mitigate the impacts of deforestation on climate change, efforts are being made to reduce forest loss and promote reforestation and afforestation, which involves planting new trees in areas that were previously deforested. Deforestation is a significant environmental issue in India, with the country losing a substantial amount of forest cover in recent years. The Indian government has implemented several policies and initiatives to address deforestation, including the National Forest Policy and the National Afforestation Programme. Moreover, India has set a target to increase its forest cover to 33% of its total land area, up from the current estimate of around 24%.

Moving from climate risks to climate-resilient development

Climate risks are likely to increase in the future due to the ongoing process of climate change. It is therefore essential to develop a proactive approach toward climate change adaptation to minimize the environmental, social and economic losses. Investing in climate-resilient development can bring many co-benefits, such as improved human health and well-being, increased food security, and enhanced biodiversity conservation. It hugely provides opportunities for renewable energy, energy efficiency, and ecosystem restoration. International climate agreements such as the Paris Agreement and the Sustainable Development Goals emphasize the need for countries to take strong action to adapt to climate change and build resilience. As a signatory to these agreements, India has committed to developing a climate-resilient economy and society.

Climate resilient initiatives by India

India has taken several climate-resilient development actions to defend against the impacts of climate change. Some of these actions include:





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CONCLUSION

India is highly endangered by the impacts of climate change, including increased frequency and intensity of extreme weather events, sea level rise, and changing precipitation patterns. To mitigate the impacts of climate change, India has taken several steps, which include, adopting a goal of generating 40% of its energy from renewable sources by 2030, which will help to reduce greenhouse gas emissions, implementing energy efficiency measures in industries, buildings, and appliances to reduce energy consumption and related emissions, encouraging the use of public transportation, electric vehicles, and clean fuel technologies, promoting reforestation, developing climate-resilient agriculture and irrigation practices, including soil conservation, rainwater harvesting, and drought-resistant crops, enhancing the resilience of coastal communities to sea level rise and increasing the capacity of infrastructure to withstand extreme weather events and finally, encouraging public awareness and education about climate change, including through initiatives like the International Solar Alliance and the Coalition for Disaster Resilient Infrastructure. Addressing the social and environmental impacts of climate change in India requires a multi-faceted approach that involves mitigation, adaptation, and building resilience. It is essential to recognize that climate change is a global challenge that requires collective action, and India, as a developing nation, has to take significant steps to address the issue and build a more sustainable future for its people.

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Table 1. Cointegration regression test of tree cover loss and CO₂ emission

Cointegrating regression - OLS, using observations 2001-2021 (T = 21) Dependent variable: TC

	coefficient	std. error	t-ratio	p-value	
const	5195.54	1709.89	3.039	0.0068	***
CO2	0.00193703	3.27127e-05	59.21	5.10e-023	***

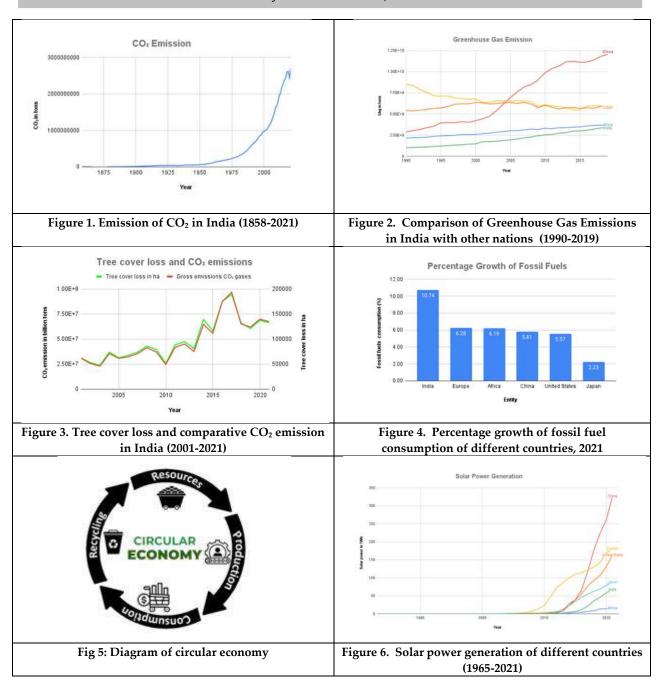
Table 2. Project initiated by India against climate change

No.	Project	Purpose
1	National Action Plan on Climate Change (NAPCC)	India launched its NAPCC in 2008, which outlines eight national missions on various aspects of climate change, including energy efficiency, sustainable habitat, and water conservation.
2	International Solar Alliance (ISA)	In 2015, India launched the ISA in partnership with France to promote the adoption of solar energy in developing countries.
3	National Clean Energy Fund (NCEF)	India established the NCEF in 2010 to support renewable energy and energy efficiency projects.
4	Green India Mission	India launched the Green India Mission in 2014, which aims to increase forest cover and improve the quality of existing forests.
5	Climate Smart Agriculture	India has implemented several initiatives to promote climate-smart agriculture, such as promoting the use of drought-resistant crop varieties and improving water management.
6	Climate-resilient infrastructure	India has taken steps to develop climate-resilient infrastructure, such as building sea walls and improving drainage systems to prevent flooding.





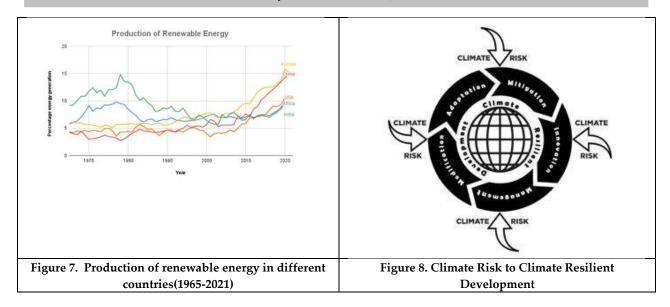
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REVIEW ARTICLE

A Review on Pharmacology of Cinnamon Bark

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ABSTRACT

Without spices, the culinary world would come to a standstill. Similar to its botanical leafy counterparts, herbs, spices add a variety of flavors, colors, and tastes to a wide range of dishes worldwide. They also provide a wealth of potent phytonutrients that have the potential to improve human health and wellbeing. Although culinary spices have been used for thousands of years due to their many health advantages, in the past 20 years, a great deal of research has been able to uncover and explain the vast array of magical, hidden wonders that these spices contain. As people become more conscious of the negative consequences of modern chemicals, pills, and medications, they are turning to traditional medical systems, of which spices are an essential part. Humans have been using them as food and medicine for many years. There is growing scientific proof that many of these spices and herbs have therapeutic qualities that help prevent illness or lessen its symptoms. Examining medicinal plants for phytochemical content and antibacterial activity can help establish a foundational framework for further research in this area. Recently, there has been a greater emphasis on screening in an attempt to discover novel antimicrobial medications. Recent research on the pharmacological effects of cinnamon bark on biological systems is reviewed in this study.

Keywords: Cinnamon bark, Phytochemicals and Pharmacology





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INTRODUCTION

Since the dawn of human civilization, people have used plants and plant-based products as medicines. The "Rigveda," which is thought to be the oldest collection of human knowledge and to have been composed between 4500 and 1600 B.C., has the earliest reference of the medical use of plants in Hindu culture. The eight divisions of Ayurveda, the Hindu culture's primary system of medicine, deal with different facets of the science of life as well as the art of healing (10). The "Rasayana" medicinal plant has been useful in improving the worst conditions brought on by microbial illness. Moreover, therapeutic plants are a great supply of structures that could be employed to develop new chemotherapy drugs. Throughout history, new and plant-derived medications have been developed from plants and these medications have significantly improved human health and wellbeing. Up until now, researchers have only experimentally demonstrated the medicinal potential of a small number of plants; the therapeutic potential of many more species is still unknown. The potential of plant-derived compounds to regulate microbial development has been scientifically proven and empirical data on the antibacterial activity of diverse plants are now being gathered. The most plentiful source of medications for traditional medical systems, contemporary pharmaceuticals, nutraceuticals, food supplements, traditional medicines, pharmaceutical intermediates and chemical entities for synthetic drugs is the kingdom of plants (3). Most of the investigated plants showed antibacterial characteristics, according to an analysis of various kinds of medicinal plants for biologically active components known to have pharmacological activities (4). The use of plant based drugs for treating various ailments is known to humans since thousands of years. Herbs and spices have been used since ancient times, not only as antioxidants and flavoring agents, but also for their antimicrobial activity against pathogenic microorganisms. Cinnamomum zeylanicum, a member of the family Lauraceae, has a long history both as a spice and as a medicine. Cinnamon possesses potent antibacterial, antifungal, antitermitic, larvicidal, nematicidal, and insecticidal properties. The chemical composition of cinnamon is broadly explored. Plants produce large amounts of compounds known as phytochemical and each part of the plant has different phytochemicals which has immense medical values (4).

Cinnamon - A Medicinal bark

The Lauraceae family includes the evergreen tree of tropical medicine, cinnamon (*Cinnamonum zeylanicum and Cinnamon cassia*). One of the most significant spices that people use on a daily basis worldwide is cinnamon. Essential oils and various derivatives like cinnamaldehyde, cinnamic acid, and cinnamate are the main ingredients of cinnamon. Cinnamon is a chemical that lowers cholesterol, lowers inflammation, lowers blood sugar, fights cancer, is antibacterial, anti-inflammatory, antidiabetic, and has been shown to have effects on neurological conditions including Parkinson's and Alzheimer's. Cinnamon is mainly used in the aroma and essence industries due to its fragrance, which can be incorporated into different varieties of foodstuffs, perfumes, and medicinal products. The most important constituents of cinnamon are cinnamaldehyde and *trans*-cinnamaldehyde (Cin), which are present in the essential oil, thus contributing to the fragrance and to the various biological activities observed with cinnamon (10). A study on *Cinnamonum osmophloeum* (*C. osmophloeum*) indicated that the essential oil from cinnamon leaves contains a high level of Cin. Consequently, *C. osmophloeum* is also used as an alternative spice for *C. cassia* (9).

METHODOLOGY

This review study was carried out based on the available literature survey on the medicinal properties of cinnamon Bark from various databases between 2007, including peer reviewed journals, PubMed (http://www.ncbi.nlm.nih.gov/pubmed), Science Direct (http://www.sciencedirect.com/), Scopus (http://www.scopus.com/) and Google Scholar (http://www.scholar.google.com/).

Pharmacology

Cinnamon can also improve the health of the colon, thereby reducing the risk of colon cancer. Cinnamon is a coagulant and prevents bleeding (4). Cinnamon has been used as anti-inflammatory, antitermitic, nematicidal,





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mosquito larvicidal, insecticidal, antimycotic and anticancer agent (5). Cinnamon has also been traditionally used as tooth powder and to treat toothaches, dental problems, oral microbiota, and bad breath (3).

Phytochemicals

Cinnamon is composed of many compounds with a biologically active formula on which its properties depend. Extracts taken from various parts of the plant differ significantly in chemical composition (Figure 1). This means that they have different properties. Volatile oils extracted from the leaves, bark, and root bark of the cinnamon plant contain the same spectrum of monoterpene hydrocarbons. However, they differ in their main compounds. Cinnamon aldehyde is the basic compound found in the cinnamon bark. The leaf oil contains mainly eugenol, whereas in the root bark oil the primary compound is camphor (2). Cinnamon is an attractive spice because of its taste, but it may also be of pharmaceutical interest. Secondary metabolites constitute a large proportion of synthetic compounds with health-promoting effects. Most of them are dietetically neutral, but they usually have a positive effect on human health. Plant oils are considered to be one of the safer compounds used in medicine. They are used in a wide range of food recipes as natural antioxidants. The pharmacological properties come from polyphenolic constituents, including phenolic acids coumarin and proanthocyanidin, as well as volatile essential oils (6). Singh $et\ al.$, 2007 reported that the spicy taste and fragrance are due to the presence of cinnamaldehyde and occur due to the absorption of oxygen. As cinnamon ages, it darkens in color, improving the resinous compounds. The presence of a wide range of essential oils, such as trans-cinnamaldehyde, cinnamyl acetate, eugenol, L-borneol, caryophyllene oxide, b-caryophyllene, L-bornyl acetate, E-nerolidol, α -cubebene, α -terpineol, terpineolene, and α -thujene, has been reported (9).

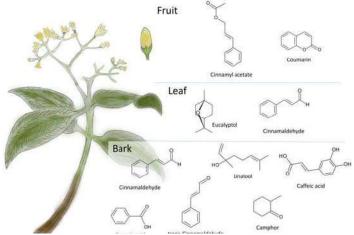


Figure 1. Selected bioactive compounds of cinnamon in different parts of the plant Image Courtesy: https://www.mdpi.com/1999-4907/12/5/648

Antioxidant Properties

Antioxidant compounds are important in human life as health-protective agents. They are present in natural food, but they are also additives in the food industry used to prevent deterioration. One of the sources of antioxidant compounds is cinnamon. This simple spice can affect diseases. (1) showed that cinnamon bark infusion has high antioxidant activities due to the presence of polyphenols and volatile oil compounds. Simple preparation of extract can be applied as a high antioxidant issue. Cinnamon spice is a source of natural antioxidants that play a key role in the process of aging and diseases. Cinnamonum zeylanicum and Cinnamonum cassia (L.) J. Presl have the highest potential. Extract from the bark of this kind contains biologically active compounds such as eugenol, transcinnamaldehyde, and linalool. Phytonutrients have been investigated in the stabilization of palm oil. They prevent the generation of alcohols, ketone, aldehyde, acids, and hydrocarbons. The addition of antioxidants inhibits episodes of the oxidation process of oil, reducing the production of dangerous oxidative derivates and free fatty acids (8)





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CONCLUSIONS

The current study has provided some comparative biochemical information on the nearby, mineral element and phytochemistry of *Cuminum cyminum and Cinnamomum verum*. These findings support the study plants' traditional uses and imply that some plant extracts contain compounds with antimicrobial properties that can be further investigated for antimicrobial activity. This investigation into the antibacterial properties of plant extracts showed that traditional medicine can be just as successful in battling harmful microbes as contemporary medication. These plants have been used in folk medicine for millennia, which suggests that they offer an affordable and secure alternative to treat infectious disorders. It appears that all therapeutic plants are reliable providers of vitamins, minerals, and phytochemicals. It is therefore quite promising to utilize them as nutritional supplements.

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CONFLICTS OF INTERESTS

The authors have no conflicts of interest to declare.

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RESEARCH ARTICLE

Neuromarketing with AI: A Way to Delve into the Consumer's Subconscious Mind

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ABSTRACT

As consumer behaviour becomes increasingly complex, traditional methods of market research often fall short of capturing the intricate motivations that drive purchasing decisions. Simultaneously, the application of Artificial Intelligence (AI) enables marketers to develop more persuasive strategies with less effort. In this dynamic landscape of contemporary marketing, the influence of Neuromarketing and AI has unveiled a remarkable realm of consumer insights and strategic possibilities, redefining the very essence of how brands engage with their audiences. The comprehensive framework of this conceptual paper aims to understand the various dimensions of Neuromarketing, combining AI and examining how certain cues and messages impact our emotions and thoughts, ultimately influencing purchasing decisions with the help of AI. Furthermore, it explores the potential of Neuromarketing and AI in uncovering insights from the consumer's subconscious mind. An investigation into the applications of AIpowered neuroscience-based tools and techniques in intelligent marketing, leading to real-time content marketing grounded on users' brain responses, will enable companies and marketers to gain a deeper insight into consumer behaviour and preferences. Thus, here we attempt to conclude the paper by discussing the future impacts of AI-empowered Neuroscience techniques on emerging marketing strategies

Keywords: Artificial Intelligence, Brain Responses, Consumer behaviour, Neuromarketing





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INTRODUCTION

Have you ever wondered how businesses seem to know your needs before you do? Well, hats off to the power of artificial intelligence (AI), a by-product of the technological advancement in the Fourth Industrial Revolution (IR4). AI has emerged as a technology of great significance and even if we are not aware of it, we interact with AI daily. Humans invented Artificial Intelligence (AI) because they wanted to go beyond their intelligence in order to understand better the world live simply and make everything convenient. AI functions as an accelerator to human intelligence and its application covers various sectors like health care, finance, retail, automotive, manufacturing, education, marketing, gaming and entertainment etc., The integration of artificial intelligence (AI) is fundamentally transforming the marketing landscape, utilizing advanced algorithms and data analysis on a large scale. This approach enhances customer experiences by efficiently utilizing technology and data. Al's rapid advancement is reshaping the marketing sector, improving decision-making through better customer data utilization, leading to increased productivity and time savings. The primary driving force behind integrating AI into marketing is competitive pressure. Consequently, AI is progressively becoming an indispensable component of our daily lives. While AI holds numerous promising applications for the future, its application in marketing is still in its infancy. However, an alluring AI-enabled marketing strategy that is gaining traction is 'Neuromarketing'. Neuromarketing is a multidisciplinary field that merges neuroscience, psychology, and marketing to decipher how the brain responds to various marketing stimuli, opening new possibilities for effective marketing techniques.

Despite the fact that we think of ourselves as intellectual beings, our decisions are actually made by the primitive instinct subconscious section of our brain, also known as our reptilian brain. Neuromarketing is the field that combines neuroscience psychology and marketing to understand how the brain responds to marketing stimuli. It is mainly a result of a combination between marketing and new technologies (Eye-tracking, facial recognition, etc.). By connecting AI to Neuromarketing technologies, marketers can better read and interpret our subconscious inclinations during the shopping process. The synergy of AI with neuro equips marketers with the tools to navigate the complex landscape of consumer decision-making and tailor their strategies more effectively. Moreover, neuromarketing has made significant contributions to the field of marketing through techniques such as Eye Tracking, Emotional Analysis, Neuro-pricing, Content Optimization, and shaping Brand Perceptions. Thus, the marketing landscape is undergoing continuous and dynamic changes, largely propelled by the transformative influence of artificial intelligence (AI). Although foundational concepts and principles have long been studied to address marketingrelated challenges [1] (Wierenga & Bruggen, 2000), the widespread integration and deployment of AI in marketing have only recently come to the forefront [2] (Wierenga, 2010). While several studies have contributed to the literature on AI-powered neuroscience applications in marketing, the paucity of research in a comprehensive examination of the intertwined potential of AI and neuromarketing in shaping consumer behaviours remains a research gap. Martínez-López & Casillas (2013) [3] point out that Scopus, a prominent database, contains fewer than fifty publications in business journals that specifically link marketing and AI. This lack of substantial exploration highlights the need for further investigations to delve into this unexplored realm [4] (Sheshadri et al., 2024). The present conceptual paper seeks to address this gap and contribute novel insights to the existing literature by presenting fresh perspectives on intelligent marketing that can be valuable for marketers seeking innovative strategies. Thus, this study bridges the existing research gap by shedding light on the uncharted territory of AIdriven Neuromarketing, providing not only a broader understanding of its potential but also a roadmap for its future development within the marketing landscape.

How Neuromarketing and Artificial Intelligence Works Together.

AI may make Neuromarketing more interesting from the point of view of measurement accuracy it has been demonstrated that an Artificial Intelligence based system, can be effective enough to assure the extraction and recognition of all sorts of emotions of individuals, regardless of gender and race [5] (Mouammine & Azdimousa, 2019). We are not a mindless shopping zombie but we make our decisions subconsciously and that's where Neuromarketing comes in. What neuroscience does is it gives us access to some of these emotional elements or these





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elements that may not be fully conscious and tells us a little bit more about some of the things that might also be contributing to people's experiences and choices? Over the last few decades, neuroscience researchers have confirmed that about 95 % of decisions are made unconsciously. The integration of AI in Neuromarketing studies using the advertising, branding and the appreciation of the product/service in all its components, it will especially help build bias-free judgments and conclusions [6] (Gwagwaet al., 2020).for this purpose, we use several techniques like;

Functional Magnetic Resonance Imaging (FMRI)

FMRI maps brain activity through the recognition of changes connected with blood flow using an MRI scanner (Huettel, Song, & McCarthy, 2009). It tests subjects lying on a bed with their head surrounded by an MRI scanner that uses the atom particles in the head to support themagneticfield [7] (Varghese, 2022).

Electroencephalography (EEG)

EEG tests and records electrical activity inside the brain using electrodes placed on to the scalp of a person [8] (Solnais et al., 2013). It recognises the variations in electrical currents that are recorded as brainwaves when a person is exposed to marketing stimuli.

Magnetoencephalography (MEG)

MEG detects a brief change in brain activity and assess the value of marketing stimulus [9-10] (Bercea, 2012; Morin, 2011). When a person is exposed to a marketing stimulus, it picks up changes in magnetic fields brought on by electrical brain activity.

Eye Tracking Techniques

ET, offers detailed insights into how emotions and decision-making work. A computer-connected sensor is used to track a user's gaze, as well as to identify their presence and track their attention and focus. It analyzes the cornea and pupil using infrared light that evokes corneal reflection [11] (Venkatramanet al., 2015). These techniques measure physiological responses that a consumer subconsciously creates while seeing an advertisement on social media about a particular product. Our reptilian brain is the decision-making part where marketers are focused on creating brand images in the minds of customers [12] (Etzold et al., 2019).

Applications of AI-Powered Neuroscience Techniques in Marketing

AI-powered neuroscience techniques have the potential to impact emerging marketing strategies in several ways significantly;

Deeper Consumer Insights

More precise consumer segmentation is possible with Artificial intelligence (AI), which has the capacity to analyse enormous volumes of neurological and psychological data, giving marketers a deeper comprehension of consumer behaviour.

Content Optimisation

Using AI, marketers may make material (such as ad copy, images, and videos) more resonant with the target audience by optimising it based on neurological responses.

Personalization

AI can personalise marketing messaging and product recommendations based on individual preferences using neuroscience data.

Predictive Analytics

Based on neural data, AI can estimate customer behaviour, enabling marketers to foresee trends and modify their plans as necessary.





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Emotionally Intelligent Advertising

Through Al-enabled analysis of emotional triggers from neuroscience, marketers can create emotionally intelligent advertising campaigns that resonate deeply with consumers and leave a lasting impact.

Neurofeedback in Design

Al can assist in website and app design by optimizing layouts, colour schemes, and user interfaces that may elicit positive emotional responses and create a more enjoyable user experience.

Chatbots and Virtual Assistants

Al-driven Chatbots and virtual assistants can engage with customers in real-time, providing personalized recommendations and assistance that make interactions more emotionally appealing and persuasive.

A/B Testing

Al can automate A/B testing processes to quickly identify which variations of marketing materials are most effective creating these variations by likely to generate stronger emotional responses. These methods have the power to fundamentally alter how businesses interact with, comprehend, and influence their customers. Businesses that use AI-powered neuroscience techniques early on may have an advantage in the marketplace by producing more successful and emotionally engaging marketing campaigns.

CONCLUSION AND RECOMMENDATIONS

In conclusion, businesses have a unique opportunity they incorporate AI-powered neuroscience methodologies into cutting-edge marketing strategies. The integration of AI in Neuromarketing will especially help in buildingbiasfreejudgments and conclusions [6] (Gwagwa et al., 2020). The landscape of customer interaction is about to be completely changed by the incorporation of AI-powered neuroscience techniques into new marketing strategies. This fusion of technology and cognitive science gives marketers new insights into the nuances of customer behaviour, opening the door for data-driven, hyper-personalized marketing. However, it is crucial to use this strong tool responsibly. A key problem for corporations in the upcoming years will be finding a balance between utilising the potential of AI-driven neuroscience and protecting consumer rights. Furthermore, studies need to be conducted on AI and Neuromarketing as it has an emerging trend and relevance in the marketing landscape. We can explore the ethical implications of using AI in neuromarketing considering different dimensions like impacts of it on different cultures and societies, privacy, consent, and the potential for manipulations etc., Also investigate the use of AI to generate marketing content, such as ad copy, design elements, and product recommendations, based on Neuroscientific principles etc. In the end, how well businesses use these technologies to better understand and serve their target audience while keeping ethical norms in data usage and customer engagement will determine the impact of AI-powered neuroscience techniques on marketing tactics in the future. In summary, neuroscience techniques backed by AI have the potential to revolutionise marketing by improving the effectiveness of ads and boosting consumer experiences.

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RESEARCH ARTICLE

Effect of Web Spacing on Balance and Functional Reach Test in Post Stroke - An Experimental Study

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ABSTRACT

Aim to know the effect of web spacing on balance and functional reach test in post stroke patient. The purpose of the study is to apply the balance training along with Web spacer to know the effect of balance training and to identify the result of balance training on Stroke patients. Stroke is a neurologic disorder caused by an abnormal blood supply to the brain. Many patients experience difficulty with movement, including balance issues and gait disturbances, after stroke. Study was undertaken on 20 subjects with age 30-60 year & diagnosed with Stroke. All the subjects was received intervention for 4 weeks per 3sessions/week. Functional reach test and Berg balance scale was used before and after the treatment. Data was analysed on SPSS software. Pre and Post test data were compared. Independent z test performed. The result of p-value 0.00 is obtained. Four weeks balance training along with web spacer is effective in post stroke patients.

Keywords: Many patients experience difficulty with movement, including balance issues and gait disturbances, after stroke.

INTRODUCTION

Patients who have had a stroke are less able to balance because they can shift over 80% of their body weight to the nonparetic side and only occasionally load their weight on the paretic side(1,2). This may restrict a stroke patient's range of motion and raise their risk of falling (3). Compared to the stance phase, stroke patients' reduced gait





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capacity is particularly significant during the swing phase. In particular, these patients' impaired gait is characterized by foot drop brought on by reduced ankle dorsiflexion during the swing phase(4,5). The quality of life is particularly impacted by diminished balance and gait function as well as social isolation in the community (Ada, Dean, Hall, Bampton & Crompton, 2003; 31 Dean, Richards & Malouin, 2000)(6). According to this, stroke patients' quality of life may be enhanced by enhancing their gait and balance (Garland, Ivanova & Mochizuki, 2007)(7). Duncan et al. (1990) developed the Functional Reach Test (FRT) to assess people's upper bounds on stability when reaching forward while standing. The maximum distance that the center of mass can be moved safely without causing changes to the base of support is known as the limits of stability. Stability control limits are necessary for carrying out daily tasks safely, particularly when those tasks include reaching for an object or target from many directions. The boundaries of stability are maintained or regained through anticipatory and compensatory postural mechanisms and methods(Wernick-Robinson, Krebs, & Giorgetti, 1999)(8). The FRT was created to evaluate dynamic balance when standing and reaching forward, although recent research has cast doubt on its use in determining stability limits and falling risk(9). According to Wallmann (2001) and Thomas and Lane (2005), the FRT is not a good way to distinguish between older persons who have fallen and those who have not. Moreover, Wallmann (2001) and Jonsson et al. (2003) came to the conclusion that the reach task differs from the limits of stability due to the trunk movements made during the FRT(10,11). As a functional outcome measure in the International Classification of Functioning domain of activity, the Berg Balance Scale (BBS) can assess a patient's capacity to carry out an action or task(12,13). The BBS was initially created with the senior population in mind and tests both functional mobility and balance. For patients with both subacute and chronic stroke, the American Physical Therapy Association Neurology Task Force strongly advises using the BBS in the following contexts: outpatient, home health, skilled nursing, and inpatient rehabilitation. It is also advised to employ the BBS in acute stroke and acute care situations.

Anecdotal clinical evidence showing frequent use of the BBS in the rehabilitation context in this cohort led investigators to examine the validity and reliability of the BBS for assessing patients after stroke(14) The finding known as the "spacing effect" states that Information conveyed through spaced repetitions is more likely to be recalled than information delivered by massed repetitions. Practice intervals spaced so that the practice time is either the same as or less than the rest period are referred to as having a spacing effect. For many patients undergoing active rehabilitation who have limited endurance and performance skills, it is the favored mode. Performance can be enhanced without the negative effects of weariness or growing safety risks with sufficient rest intervals. When one has low motivation, a short attention span, difficulty concentrating, or a lack in motor planning, spaced practice is also helpful. If the task at hand requires a lot of energy, is huge, or is complex, then spaced practice is also taken into account. Compared to massed repetition, spaced repetition of an object or task has the potential to significantly improve subsequent performance(15). When one has low motivation, a short attention span, difficulty concentrating, or a lack in motor planning, spaced practice is also helpful. If the task at hand requires a lot of energy, is huge, or is complex, then spaced practice is also taken into account. Learning improves memory and the ability of newly formed neurons to survive. Learning trials spread out over time produce higher recall than massed learning (consecutive learning trials), according to a substantial body of research. Compared to massed repetition, spaced repetition of an object or task has the potential to significantly improve subsequent performance.

METHODOLOGY

25 Participants was Examine and 20 participants received 45 min of treatment for 3 times per week for four weeks and total 12 sessions was given. Total 20 patient was fall ininclusion criteria and was received treatment. And 5 participant was fall in exclusion criteria Balance training along with web spacer was given in form of Sit to Stand, Step up step down, Tandom walking, Reaching objects including down the floor, Ball kicking, holding object with bilateral hands while walking ,Stair climbing ,Forward and backward walking. In this experimental investigation, we use a strict technique to examine how web spacing affects post-stroke patients' functional reach test results and balance. First, we choose a representative sample of post-stroke patients, making sure that the group is diverse in terms of age, stroke severity, and past rehabilitation experience. Participants in a series of computer-based balance

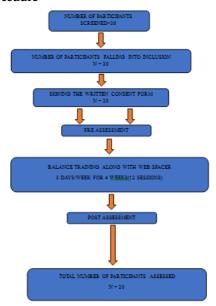




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and functional reach exercises are randomly assigned to groups exposed to different web spacing settings. The three variants of web spacing—narrow, moderate, and wide—simulate various online settings. We use standardized tests, like the Berg Balance Scale, to evaluate participants' capacity for balance maintenance during both static and dynamic tasks. Functional reach tests, which measure how far a person can reach forward without losing their balance, offer more information.

Procedure



RESULT

		Mean (SD)	SD
	FRT	6.86	0.39
PRE	BBS	14.56	2.14
POST	FRT	7.64	0.4
	BBS	13.42	2.21
PRE-POST	FRT	10.5	
	BBS	10.5	

IBM SPSS statistic software (version27.0) was used for analyzing the data. Wilcoxon signed-rank test showed a negative Z-value, indicating that the observed differences deviate from the null hypothesis. The functional reach test and the Berg Balance Scale showed a statistically significant difference in both scales.

Thus, there was positive effect of web spacing on balance in post stroke patients.

DISCUSSIONS

The aim of this study is to find the effect of web spacing on post-stroke patients' functional reach test and balance. It's critical to investigate cutting-edge therapies since stroke patients frequently struggle with maintaining balance and performing functional movements. Our goal is to determine how differences in web spacing during balance exercises





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affect the functional reach and balance abilities of post-stroke patients. In previous study, that is done by Neelima and Rama kumarsahu concluded that application of the spacing technique program with conventional therapy improves balance and gait more effectively than only with the conventional therapy. Thus, spacing effect or spaced interval practice along with conventional therapy should be considered during the management of stroke population to improve balance and gait(15). Our results show a strong relationship between increases in functional reach and balance and web spacing. Exercises with a certain web spacing showed improved stability in both static and dynamic balancing tasks for participants. The incremental and customised strategy to testing the patients' balancing abilities was made possible by the graduated changes in web spacing. According to the functional reach test results, people who were exposed to different web spacings were able to reach farther. This implies that the intervention increased functional mobility in addition to having a good impact on balance. One important element that became apparent was the flexibility of web spacing, which offered a personalised and patient-focused method of rehabilitation. The gains that have been noticed can be explained by the inherent issue that varying web spacings present. By encouraging patients to use different muscle groups, his controlled instability promoted proprioception and neuromuscular control. This flexibility is essential for post-stroke rehabilitation, as tailored interventions are essential for meeting the various demands of stroke survivors. Moreover, the favourable results beyond the short-term intervention, suggesting possible enduring consequences. The study was conducted during a brief period of time, with a moderate sample size. Further studies with a wider range of participants and longer follow-up times would provide a more thorough knowledge of the long-term advantages of web spacing strategies.

CONCLUSION

Four weeks balance training along with web spacer is effective in post stroke patients.

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RESEARCH ARTICLE

Biosurfactant-Assisted Bioremediation: A Sustainable Strategy **Revitalize Contaminated Agricultural Soils**

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ABSTRACT

A major problem for all nations is agricultural output to fulfill the expanding demands of the human population. Nowadays, it is essential to use green substances to accomplish sustainable agriculture. Scientific interest in environmental issues has always been enormous. Pollution from toxicants is a major environmental issue that has put human health and agricultural productivity at risk. The two most dangerous environmental contaminants for the natural world are heavy metals and insecticides. Various remediation strategies have been explored to mitigate this issue, among which the utilization of biosurfactant microorganisms has garnered significant attention. This review paper critically examines the role of bio-surfactants produced by microorganisms in reducing heavy metal accumulation in agricultural soils. It explores the mechanisms underlying the action of these surfactants, emphasizing their ability to enhance metal mobilization, solubilization, and subsequent plant uptake or immobilization. It also highlights the efficacy, limitations, and potential applications of bio-surfactant microorganisms in remediation processes. Insights gathered from recent studies and ongoing research endeavors elucidate the promising prospects of harnessing bio-surfactants as eco-friendly, cost-effective tools for ameliorating heavy metal-contaminated agricultural soils, thereby safeguarding both environmental health and crop productivity.

Keywords: Bio-surfactants, Bioremediation, Contaminated soil, Heavy metals, Agriculture.





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INTRODUCTION

Due to heavy metal pollution, the rapid industrialization of the world, and the extraction of natural resources for metal mining and industry have a detrimental impact on the environment. The contamination of air, land, and water by heavy metals is among the most detrimental effects that the world is presently dealing with [1;2;3]. Because of their hazardous qualities and enduring presence in the environment, heavy metals raise serious environmental concerns. Electronegative elements with densities of more than 5 g/cm3 are classified as heavy metals [4]. The primary cause of their extended persistence in the environment is their non-biodegradable nature. As a result, they move up the food chain, causing several diseases and obstructing biological pathways [5]. Furthermore, because heavy metals are hardly broken down in the soil, it is challenging for scientists to detoxify them completely. The globe continues to experience the dangerous impacts of heavy metal pollution despite the efforts made to address the problem. As a result, new technologies, such as bioremediation, should be developed to contain the catastrophe of heavy metal contamination [2;3]. Microorganisms produce a broad class of surface-active compounds called biosurfactants, which have both hydrophilic and hydrophobic moieties. They have two structural moieties: a hydrophilic moiety made up of peptide cations or anions, mono-, di-, or polysaccharides acid, and a hydrophobic moiety made up of saturated or unsaturated fatty acids or hydrocarbon chains [6;7]. Biosurfactants are more economical, easily biodegradable, and stable at high pH, temperatures, and salt concentrations than their chemical counterparts. They are also more environmentally friendly. They may therefore find application in the food, pharmaceutical, petroleum, and other industries.

HEAVY METALS

Heavy metals are defined as metals or metalloids with an atomic mass greater than 4000 kg/m-3, or five times that of water. Elemental density values over 5 g/cm3 fall into this category [8]. Although there are many elements in this class, only a few metals are frequently found in contaminated soil, water, and air. These metals include cobalt (Co), nickel (Ni), chromium (Cr), zinc (Zn), vanadium (V), tin (Sn), arsenic (As), copper (Cu), lead (Pb), and zinc (Zn). There are many different forms that these metals can take, such as soluble ones like salt and insoluble ones like carbonate, oxides, silicates, and sulfides [9]. Moreover, heavy metals such as Cd⁺², Pb⁺², Hg⁺², and As⁺³ are the most dangerous when they are in their ionic state because they combine with biomolecules to form complexes that are more difficult to dissolve [10]. Many studies conducted recently have concentrated on the mobility and diffusion in soil layers and aquifers (Cuevas *et al.* 2012). Industrial process and product use, energy generation and distribution, and industrial energy consumption are the industries that contribute most to the emission of Cd, Hg, and Pb of reports from the European Environment Agency. Nonetheless, a significant portion of Pb emissions come from homes, businesses, organizations, and cars [11].

TOXICITY OF HEAVY METAL

At present rapid industrialization and mining activities have resulted in heavy metal contamination of soil and water bodies. Heavy metal ions are naturally present in the soil, but human activities such as the application of pesticides containing metals, electroplating, mining, tanneries, manufacturing paints, batteries, metal pipes, ammunition, and sewage sludge, and disposal of wastes by various industries have abruptly increased the metal concentration in the environment [12]. Because of their toxicity in both terrestrial and aquatic environments, heavy metals like lead (Pb), cadmium (Cd), chromium (Cr), copper (Cu), arsenic (As), zinc (Zn), mercury (Hg), and nickel (Ni) have been identified as significant environmental contaminants. (Table 1).

VARIOUS HEAVY METAL REMEDIATION TECHNIQUES AND THEIR LIMITATIONS SOIL AMENDMENTS TECHNIQUE

The soil amendment technique is quite used for the removal of heavy metals, but it has some limitations [42]. When organic materials are amended in the soil, they tightly bind with heavy metal, causing difficulties in the metal removal process. This process takes more time, henceforth it affects the removal of metals. When heavy metals are present in soil at significantly higher levels than other nutrients, they can seep into nearby bodies of water and





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contaminate the water. Soil erosion was more common due to soil acidity, soil physical degradation, and related factors [43; 44; 45]. In addition to all these restrictions, the high cost and inorganic fertilizer additives may cause the concentration of heavy metals to rise [46; 47].

SAND CAPPING

Sand capping or landfill technique is the most operant technique where a large quantity of inherent waste is above the water table. This technique is applied to give an impermeable boundary to surface water invasion to the contaminated soil for the anticipation of further leaching of contaminants to the surrounding surface water or groundwater [42]. With its usefulness, this technique also has some loopholes. It cannot impede the flow of groundwater along with contaminants without any external support. In several cases, sand caps are applied in collaboration with some vertical defenders to minimize the flat stream and movement of metal pollutants. This collaboration may cause the overflow of contaminants into surrounding soil and water bodies [48]. Through this technique, we can just diminish the exchange rate of metal in sediment, while the immobilization impact of heavy metal is less [49].

PHYTOREMEDIATION

Phytoremediation is an extremely gradual process. It is mostly location- and season-dependent, hence climate change has a significant impact on it. Metals can be removed from soil via a process called phytoremediation, which uses living, green plants. With certain restrictions, it's an eco-friendly and green method. This method works only in locations where contamination is low because larger contamination concentrations could inhibit plant development [5].

ELECTROCHEMICAL REMEDIATION

Direct current technology is a more comprehensive class of advanced approaches that includes electrochemical remediation technology (ECRTs) (DCTs). To either activate or separate pollutants in soils, these procedures use an electric current throughout the treatment process. Since ECRT treatments' reaction rates are inversely correlated with grain size, they repair silts and sediments more quickly than sand and rock. The technology's operating depth is limited by the availability of drilling for electrode assembly [50; 42]. The primary constraint on this method is its energy need, which involves electric current, which is expensive and difficult to get. The solubility of the pollutant is another significant element that restricts the procedure. The desorption of contaminants from the soil matrix limits the electrokinetic process. By using this procedure, heavy metals that are harmful and contaminating soil are difficult to dissolve and remove from soil samples.

BIOREMEDIATION

According to [1], bioremediation is the process of using biological diversity directly or indirectly to change harmful contaminants into safe forms. Therefore, the employment of bacteria, fungi, plants, actinomycetes, and algae as biological agents to detoxify heavy metals is part of the complete method known as bioremediation. Remediating toxic pollutants can be done in two different ways: either by allowing native species to adapt to the pollutants by creating the ideal conditions for their propagation, or by introducing a biological agent into the contaminated area and letting the organisms decompose there. Ex-situ is the name of the second method, which involves moving the contaminated area to a new location for processing. While there are other methods by which the organism can regulate the detoxification process, the main concept is that the microbe utilizes the toxic metal as a source of nutrition [51].

THE METHOD OF ACTION OF BIOREMEDIATION

Microorganisms are crucial to the bioremediation of heavy metals because of their widespread presence and ability to interact with the metals in several ways that make them less harmful. There are two main methods by which an organism can cope with pollutants, according to [53] either it uses the contaminant as a source of sustenance, or it employs a defensive mechanism to protect itself from the negative consequences. As the microorganism interacts with environmental toxins directly or indirectly through processes including biosorption and biotransformation [52].





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ELEMENTS INFLUENCING THE PROCESS OF BIOREMEDIATION

When the biodegradation potential is compromised by selecting the optimal technique, mechanism, and methodology without taking into account the factors that might affect the applied usage, the bioremediation process's efficiency is reduced. The number of metal ions, the metal's valence state and chemical forms, its bioavailability, redox potential, the availability of low molecular weight organic acids, and environmental factors like pH and temperature might all have a substantial effect on the bioremediation process [54].

WHY SUSTAINABLE ALTERNATIVE TECHNIQUES FOR THE REMEDIATION OF HEAVY METAL IS SO IMPORTANT?

The global issue of anthropogenic activities leading to an increase in heavy metal concentrations in terrestrial and aquatic ecosystems is widespread and extremely problematic. These factors have led to extensive research on several strategies, including phytoremediation of heavy metals and mechanical, physical, and chemical approaches. The use of mechanical, physical, and chemical methods is costly and can result in partial removal of contaminants; on the other hand, phytoremediation poses a risk because plant matter may act as a conduit for contaminants to enter the food chain and biomagnify heavy metals from one trophic level to another [55]. Therefore, biosurfactant-assisted heavy metal remediation may be considered a novel biological and environmentally benign heavy metal removal method. The primary factors that make biosurfactants a viable substitute for traditional remediation agents are their low toxicity, environmental biodegradability, compatibility, ability to be produced from inexpensive organic wastes and agro-based raw materials, and ability to remain active at pH, salinity, and temperature extremes [56; 57].

BIOSURFACTANTS

Biosurfactants are surface-active substances that are stable in high salinity, pH, and temperature environments. Among their remarkable features are their enormous and multidimensional structures, their capacity to create liquid crystals, their varied chirality, and their wide range of biological functions [58]. They are biodegradable and naturally non-toxic in contrast to manufactured surfactants. Their ability to generate metal micelles is one of their most crucial characteristics and is crucial to heavy metal cleanup. The hydrophobic portion of the biosurfactant's solvophobic properties causes non-covalent interactions through self-aggregation, forming structures like micelles and vesicles. A bilayer of amphiphilic surfactants envelops hollow spheres known as vesicles, whereas micelles exist in a variety of shapes, including spherical, cylindrical, and ellipsoidal forms [59; 60]. When biosurfactant concentrations surpass the critical micelle concentration, micelle formation occurs (CMC). Micelle creation facilitates the reduction of surface tension and interfacial tension by biosurfactants, while simultaneously enhancing the solubility and bioavailability of hydrophobic organic compounds [61; 62]. The critical micelle concentration is a commonly used metric to evaluate a surfactant's efficiency. Low critical micelle concentrations of effective biosurfactants mean that very low surfactant concentrations are required to lower surface tension [63]. The development of micro-emulsions depends on the formation of micelles. A monolayer of surfactants disperses a transparent composite of oil and water domains to form microemulsions, which are generally persistent. There are two types of microemulsions: reverse microemulsion and direct micro-emulsion. Reverse micro-emulsion is the dispersion of the water phase as droplets in the oil phase, whereas direct micro-emulsion is the dispersion of the oil phase in the water [63]. The efficiency of a biosurfactant is based on its molecular mass. While high molecular mass biosurfactants can stabilize oil in water emulsions, low molecular mass biosurfactants are more successful in reducing interfacial tensions and surface tensions [61; 64; 65]. By reducing surface tension, the biosurfactants assemble at the interface between two immiscible fluids or between a solid and a fluid. According to [66 and 63], the most active biosurfactants can potentially reduce the interfacial tension between water and n-hexadecane as well as drop the surface tension of water from 72 to 25-30 mM/m.

TYPES OF BIOSURFACTANTS

Biosurfactants are generally categorized into two classes depending on the mass of the surfactant. The low-mass biosurfactants include lipopeptides, glycolipids, and phospholipids, while high-mass biosurfactants include particulate and polymeric surfactants [61; 68; 69] as listed in Table 2.





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BENEFITS OF USING BIOSURFACTANT IN METAL REMEDIATION

Numerous studies have demonstrated the benefits of biosurfactants.

LOW TOXICITY

Comparatively speaking, biosurfactants were less harmful than chemical surfactants. When analyzing the naphthalene solubilization test, [75] demonstrated that the glycolipids generated by Rhodococcus species strain 413A were 50% less hazardous than Tween 80.

BIODEGRADABILITY

Because of their biological origin and chemical makeup, biosurfactants are lowly poisonous and quickly broken down by microorganisms [76].

BIOCOMPATIBILITY

The biological origin of biosurfactants renders them an inherent feature of biocompatibility, which allows their usage in agricultural fields, the cosmetic industry, functional food additives, and pharmaceuticals [76].

PRODUCTION FROM INEXPENSIVE MATERIALS

Agro-industrial and organic waste are two cheap raw sources that are readily available for the production of biosurfactants [76].

MICROBES FROM SOIL ENVIRONMENT AS PRODUCERS OF BIOSURFACTANTS

Numerous researchers recommend looking for bacteria that create biosurfactants in a variety of environmental niches, such as soil, water, and leaf surfaces [77]. Many different bacteria connected to rhizospheres and plants create biosurfactants, suggesting that they could play a role in plant-microbe interaction and be valuable in agriculture in the future.

AGRICULTURE-RELATED APPLICATIONS OF BIOSURFACTANTS

Given that biosurfactants sourced from microorganisms exhibit both hydrophobic and hydrophilic characteristics [78], these surfactants are better for the environment than those made by chemical synthesis. These biosurfactants can be widely employed in agricultural regions to indirectly boost plant development and encourage favorable plant-microbe interactions since they have antibacterial activity and can speed up the biodegradation of contaminants to improve soil quality. These natural surfactants are utilized as a carbon source by soil-dwelling bacteria [79; 80; 81]. Therefore, these biosurfactants can replace the aggressive surfactants now used in the pesticide sector. This elucidates the biological mechanisms involved in the removal of biosurfactants from agricultural soil.

POTENTIAL OF BIOSURFACTANTS IN PESTICIDE INDUSTRIES

Since many biosurfactants generated from bacteria have antibacterial action against plant illnesses, they are considered a possible biocontrol chemical for achieving sustainable agriculture. It is commonly recognized that hostile biosurfactants are produced by rhizobacteria [82]. The biocontrol mechanisms of plant growth-promoting microbes, such as competition, induced systemic resistance, antibiosis, parasitism, and hypovirulence, are also supported by chemical and biosurfactant applications in agriculture [78]. Surfactants are widely employed in agriculture to increase the virulence of microorganisms and microbial products. Numerous in situ and in vitro investigations have shown how surfactants enhance the insecticidal properties of other systems. Additionally, according to [83], these surfactants are used in conjunction with a fungus known as *Myrothecium verrucaria* to eradicate weed species that negatively affect biodiversity and land production. Surfactants are also known to stop Aspergillus sp. from producing aflatoxin when it infects crops like corn, peanuts, and cottonseed, both in storage and on agricultural fields [84]. Furthermore, rhamnolipids have been demonstrated to enhance plant immunity, which is believed to be an alternative strategy to reduce plant pathogen infection [84].





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PLANT PATHOGEN ELIMINATION BY BIOSURFACTANTS

The soil-dwelling Bacillus subtilis, which generates biosurfactants, is thought to suppress the anthracnose-causing Colletotrichum gloeosporioides on papaya leaves [86]. Research has shown that a biosurfactant generated by *Staphylococcus* sp. isolated from crude oil-contaminated soil suppresses *Pseudomonas aeruginosa*, a suspected plant pathogen [87]. The examples above demonstrate how the literature on promoting plant development has thoroughly investigated the harmful effects of green surfactants on pathogens. Therefore, these biosurfactants and/or the microorganisms that produce biosurfactants may replace the hazardous chemical pesticides and insecticides that are now utilized in agriculture. In addition to their anti-phytopathogenic qualities, biosurfactants are believed to quicken the compositing process by fostering an environment that is conducive to microbial development.

METAL REMEDIATION IN CO-CONTAMINATED SOILS

The rehabilitation of soil polluted with organic compounds and metals presents difficulties [88]. These sites are particularly difficult to remediate because metals are not biodegradable and reduce the ability of microbes to break down hydrocarbons [89]. The first study on the usefulness of surfactants in co-contaminated site restoration was published by [90]. To illustrate the metal toxicity connected to the biodegradation of polyaromatic hydrocarbon in the presence of surfactant-modified clays, they created a model system that included Pseudomonas putida breaking down naphthalene in the presence of cadmium. They observed that the surfactant-modified clay combination reduced the toxicity of cadmium to Pseudomonas putida. Therefore, the study shows that the clay adsorbent enhanced with surfactant is a cost-effective and efficient technique for remediating co-contaminated soil. Yet the majority of surfactants synthesized chemically demonstrated toxicity. Therefore, biosurfactant-producing microbes may be a superior option for remediating co-contaminated soil [91] investigated the efficacy of rhamnolipid, a biosurfactant, in the cleanup of a site co-contaminated with cadmium and naphthalene. They discovered that rhamnolipid, a biosurfactant, might lessen cadmium toxicity and promote the breakdown of naphthalene. When added at a tenfold higher concentration (890 lM), rhamnolipid biosurfactant eliminated the toxicity of cadmium, however at tenfold lower concentrations, decreased toxicity at an equimolar dosage (89 lM) had no impact (8.9 lM). They postulated that a combination of rhamnolipid complexation of cadmium and rhamnolipid interaction with the cell surface to modify cadmium absorption resulting in higher rates of bioremediation is the mechanism by which rhamnolipid biosurfactant decreases metal toxicity. According to [92], copper and zinc may be extracted from hydrocarboncontaminated soil using rhamnolipid, surfactin, sophorolipids, and all other anionic biosurfactants. According to [81], lipopeptide biosurfactants may be effectively employed to remove organic contaminants and heavy metal ions at the same time. One benefit of using biosurfactants in the restoration of co-contaminated soil is that they may be created in situ using waste and organic pollutants as substrates, which lowers the cost of cleanup [94].

CONCLUSION

The application of biosurfactants in the remediation of heavy metals is of great interest, owing to their biodegradability and low toxicity. This review underscores the pivotal role of bio-surfactants produced by microorganisms in addressing heavy metal accumulation in agricultural soils. The utilization of bio-surfactants produced by microorganisms emerges as a promising and eco-friendly strategy for addressing the pressing issue of heavy metal contamination in agricultural soils. The multifaceted mechanisms employed by these surfactants, including enhanced mobilization and solubilization of metals, underscore their potential in mitigating environmental risks and promoting sustainable agriculture. Despite their efficacy, the review acknowledges certain limitations and emphasizes the potential applications of bio-surfactant microorganisms in soil remediation. Overall, the insights gleaned from recent studies suggest that harnessing bio-surfactants offers promising prospects for environmentally friendly and cost-effective strategies to mitigate heavy metal contamination in agricultural soils, safeguarding both environmental health and crop productivity.





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Table 1. Toxicity profile of heavy metals [41]

Heavy metals	Toxicity on human beings	Toxicity on plants	References
Cadmium (Cd)	Causes renal dysfunction, obstructive lung disease, and cadmium pneumonitis (resulting from inhaled specks of dust and fumes). It also causes chest pain, cough with foamy and bloody sputum, and death of the lining of the lung tissues. Osteomalacia, osteoporosis spontaneous fractures (bone defects), increment within the blood pressure, and myocardial dysfunctions.	Reduction in photosynthesis, nutrients, and water uptake. Chlorosis, growth inhibition, browning of root tips and eventually death	[13], [14], [15], [16], [17].
Mercury (Hb)	Exerts neurotoxicological disorders, gingivitis, damage to the central nervous system and brain, psychological changes, and congenital malformation	Causes physical blockage of water flow in plants, causes stomata on leaves to close, and causes physiological abnormalities in plants.	[18], [19], [20], [21]
Lead (Pb)	Affects the kidneys, gastrointestinal tract, reproductive system, and joints. Inhibition in hemoglobin synthesis also causes chronic or acute damage to the nervous system	It negatively impacts plant development, morphology, and photosynthetic activities. It also inhibits enzyme activity, unbalances water content, modifies membrane permeability, and disrupts mineral feeding.	[22], [13], [18], [23]
Arsenic (As)	It irritates the stomach, lungs, intestine, and skin and decreases the formation of red blood corpuscle and white blood corpuscle. Very high concentrations of inorganic arsenic can cause infertility, brain damage and death, and heart disruptions.	Arsenic is non-essential and generally toxic to plants. As a phosphate analog, arsenate can interfere with certain phosphate-dependent metabolic processes. Excess amount inhibits proliferation and root extension. Upon translocation to the shoot, it can adversely affect the plant growth by arresting expansion and biomass accumulation	[24], [25], [26], [27]
Copper (Cu)	In humans, copper is essentially needed, but their high doses lead to anemia, liver, and kidney damage, and stomach and intestinal irritation. When Wilson's disease is present, significant.	Copper inhibits the growth and alteration of plasma membrane permeability. Its toxicity can also induce the deficiency of essential elements and lead to inhibition of the element-ion-dependent reaction	[28], [29]
Chromium (Cr)	Chronic exposure can damage the kidney, circulatory, nerve tissues, and liver. It also gets accumulated in the fish and can cause toxicity while eating those fishes	Excess amount of chromium leads to inhibition of plant growth and chlorophyll biosynthesis, chlorosis in young leaves, nutrient imbalance, and root injury	[28], [30], [31], [23], [32], [33]
Zinc (Zn) Zinc is considered non- toxic when taken	Anemia, liver, kidney failure, icterus (yellow mucus membrane), vomiting, diarrhea, and bloody urine are all signs	Its toxicity retards both the root and shoot of the plant and leads to chlorosis, senescence. Excess	[34], [14], [35], [36],[37],





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orally	of zinc poisoning. When used in excess,	amounts of Zn can also give rise to	[38], [39]
	it causes system malfunctions that	manganese, copper, and	
	impede growth and reproduction.	phosphorus deficiencies in plants	
Selenium (Se)			
Both humans and	Selenium toxicity fatigues, irritability,		
other animals	and damages liver tissue, the nervous		
require tiny	system, kidney, and circulatory tissue. It	Overdosing on selenium in plants	
amounts of	also gets accumulated in the fish and can	can hurt seed germination and	[28], [40]
selenium (Se), but	cause toxicity while eating those fish.	growth.	
excessive levels	Sometimes there may be a problem with		
can be	hair and fingernail loss due to Se		
detrimental.			

Table 2: Types of biosurfactants Modified from [61]; [65]; [41]

Table 2: Types of biosurfact	Biosurfactant			
Groups	Class	Producing microorganism	References	
Glycolipids: Low molecular weight biosurfactants called glycolipids are made of long-chain aliphatic acids with carbohydrates attached.	Rhamnolipids: Glycolipids known as rhamnolipids are made up of a mono- or dimer of b-hydroxy fatty acids with one or two L-rhamnose molecules. Trehalolipids: trehalolipids are glycolipids that contain trehalose lipids as a hydrophilic moiety. Sophorolipids:Glycolipids known as sophorolipids are those in which a long-chain hydroxyl fatty acid is connected to	Pseudomonas aeruginosa, Pseudomonas sp., Burkholderia sp Mycobacterium tuberculosis, Rhodococcus erythropolis, Arthrobacter sp., Nocardia sp., Corynebacterium sp Torulopsis bombicola, Torulopsis petrophilum, Torulopsis apicola,	[70], [65], [64] [71], [72] [71], [64], [73]	
	the dimeric carbohydrate sophorose through a glycosidic bond.	Starmerella bombicola, Wickerhamiella domercqiae, Candida batistae		
Lipopeptides: Low molecular weight biosurfactants called lipopeptides are made up of a polypeptide chain and a lipid.	Surfactin: surfactin is a cyclic lipopeptides that consist of a seven-amino-acid-ring structure coupled to a fatty-acid chain via lactone linkage. Lichenysin: lichenysin anionic cyclic lipo heptapeptide biosurfactants produced by Bacillus licheniformis.	Bacillus subtilis Bacillus licheniformis	[67], [71], [73]	
Neutral lipids, phospholipids, and fatty acids	Corynomycolic acid Spiculisporic acid Phosphatidylethanolamine	Corynebacterium lepus Penicillium spiculisporum Acinetobacter sp., Rhodococcus erythropolis	[71], [73]	





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RESEARCH ARTICLE

Evolution of Non-Alcoholic Fatty Liver Disease (NAFLD): Nutritional Management and Dietary Strategies for the Prevention and Treatment of **NAFLD**

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ABSTRACT

Over 1.5 billion people are thought to be overweight globally, making obesity a serious public health concern. The obesity epidemic is closely associated with the rising prevalence and severity of Non-Alcoholic Fatty Liver Diseases (NAFLD), by 2030, it is expected that NAFLD, the most widespread cause of chronic liver disease in Western nations, would be the most prevalent reason for liver transplantation. It has a recognized association with metabolic syndrome. However, obesity has also been closely linked with Simple steatosis (SS), advanced hepatic diseases like Non-Alcoholic Steatohepatitis (NASH), and NASH-related cirrhosis and hepatocellular carcinoma. NAFLD has become a significant public health issue in India as well as other areas of the world due to the easy availability to calorie-dense food, sedentary lifestyle, the current epidemic of diabetes mellitus (DM), and obesity. There is reportedly no therapeutic accord for the treatment of NAFLD patients, and lifestyle intervention with a focus on healthy eating, regular physical exercise, and weight loss persists in the management of NAFLD patients. The reliability of the disease identification is limited by the absence of sensitive and specific non-invasive testing for NAFLD. This study focuses on factors involved in the progression of liver disease in NAFLD: genetic influence, management of NAFLD, Emerging techniques in the diagnosis and screening of NAFLD, treatment, and dietary recommendations.

Keywords: Non-alcoholic fatty liver disease, Screening of NAFLD, Dietary modification, Obesity, India





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INTRODUCTION

Around 1.5 billion people worldwide are estimated to be overweight, with 200 million men and 300 million women being obese, making obesity a major global health issue (1). The rise in frequency and severity of non-alcoholic fatty liver disease (NAFLD) is significantly connected to the obesity pandemic. Obesity has been linked not only with Simple Steatosis (SS) but also with Non-Alcoholic steatohepatitis (NASH), NASH-related cirrhosis, and hepatocellular carcinoma (2). NAFLD has been broadly categorized as NAFL (Non-Alcoholic Fatty Liver), where there is no evidence of liver cell damage (no ballooning of hepatocytes), and NASH (Non-Alcoholic Steatohepatitis) as shown in Figure 1, which is NAFL with inflammation and liver cell damage without fibrosis. NAFLD is associated with metabolic comorbidities such as obesity, type 2 diabetes mellitus (T2DM), or dyslipidaemia and is generally considered the hepatic manifestation of the metabolic syndrome (3). NAFLD is characterized by fatty liver-related insulin resistance in the absence of significant alcohol consumption. It is a wide-spectrum disease, ranging from simple steatosis to NASH, which may further progress to cirrhosis and the end-stage liver disease hepatocellular carcinoma (HCC) (4). According to estimates, NAFLD affects 25% of the world's population and is steadily increasing due to the obesity pandemic. This increase is concerning because NAFLD is often a progressive disease that can be correlated with eloquent complications such as liver cirrhosis, hepatocellular carcinoma, and an increase in liverrelated and overall mortality (5). It is rapidly becoming the most common indication for a liver transplant (6). NAFLD and its complications pose a tremendous health burden not only in Western countries but also increasingly in Asia. The second-most populated nation in the world is India. Non-alcoholic fatty liver disease (NAFLD) has become a significant public health issue in India as well as other areas of the world due to the easy availability to calorie-dense foods, sedentary lifestyles, the current epidemic of diabetes mellitus (DM), and obesity. In India, the prevalence of NAFLD varies between 9% and 53% of the overall population (7). (https://www.ncbi.nlm.ni h.gov/pmc/articles/PMC6158334/).

PATHOPHYSIOLOGICAL MECHANISMS LINKING NAFLD AND OBESITY PATHOPHYSIOLOGY OF OBESITY

The laws of thermodynamics state that calorie intake has to be increased over calorie expenditure, it would be inappropriate to conclude that obesity results from this factor alone. Alterations in the Central Nervous System (CNS-endocrine signals) are just one among several obesogenic variables that interact in a complicated way to cause obesity. The CNS detects information associated with the metabolic needs of adipose tissue, the liver, the stomach, muscles, and bones. Hormones such as cholecystokinin, glucagon-like peptide-1 (GLP-1), insulin, and leptin are synthesized during satiety conditions that decrease food intake. Insulin and leptin are secreted primarily in response to glucose and adipose tissue, respectively. In contrast, ghrelin, which is a potent orexigenic (appetite stimulant), promotes food intake (8). The onset of obesity is greatly influenced by an obesogenic environment, which includes eating meals that are high in calories and reduced physical activity. Additionally, fast food is energy dense with a higher proportion of trans-fatty acids (TFAs) and an increase in consumption frequency, which increases the risk of heart disease and obesity (9). Genetic factors such as monogenic and polygenic alterations can lead to genetic syndromes that have obesity as a central feature. Gene mutations can also cause non-syndromic monogenic forms of obesity, such as those leading to leptin deficiency. Leptin deficiency is the only monogenic form of obesity for which successful targeted therapy has been developed (10).

FACTORS ASSOCIATED WITH OBESITY DEVELOPMENT:

Obesity is a complex and multifactorial condition that involves the interaction of several factors such as environmental, socioeconomic, genetic, and internal, including alterations in central nervous system (CNS)-endocrine signals. The below-mentioned factors have been significant contributors to the obesogenic environment and NAFLD-Table 1. (11, 12, 13, 14, 15, 16).





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NAFLD AND OBESITY

The pathophysiology of NAFLD is complex and multifaceted. Mechanisms of NAFLD include dietary factors, insulin resistance, genetic polymorphisms, lipotoxicity, and altered gut microbiota. Obesity is a significant comorbidity of NAFLD and is brought on by an imbalance between high-calorie intake (over nutrition) and energy expenditure. Over nutrition and obesity disrupt hepatic fatty acid metabolism, resulting in triglyceride build-up within hepatocytes and NAFLD (17). Steatosis results from an accumulation of fat in the form of Triacylglycerol (TAGs) in the hepatocytes and reflects different conditions (i.e. NAFLD, acute fatty liver during pregnancy, Liver transplantation, etc.) In simple terms, Hepatic Steatosis is initiated when the rate of hepatic fatty acid uptake from the plasma pool and De novo fatty acid synthesis is greater than the rate of fatty acid oxidation and export (as Triglycerides within VLDL) (18). Under standard circumstances, the liver processes a substantial quantity of Fatty acids daily but retains only a tiny amount in the form of Triglycerides (TG), with steady-state TG concentrations of less than 5% (19). High saturated fat, low fibre, and carbohydrate-rich diets are prevalent in obesity and associated with the risk of NAFLD (20).

GENETICS

NAFLD is characterized as a multifaceted disease condition with significant genetic and environmental influences. Candidate gene studies, which assess the relationship between variations in a specific gene and an interesting trait, have been used to assess genetic vulnerability to NAFLD which concludes only a small number of loci be related to the risk of NAFLD prevalence or progression, nevertheless, according to the majority of candidate gene studies. GWAS (Genome-Wide Association Studies) have identified robust and reproducible associations linked with the natural history of NAFLD including variants in the Patatin-like phospholipase domain-containing 3 (PNPLA3), the Transmembrane 6 super family member 2 (TM6SF2) and more recently in the 17-beta hydroxysteroid dehydrogenase 13 (HSD17B13) genes (21). A specific PNPLA3 gene variant has been linked to a higher risk of non-alcoholic fatty liver disease development (NAFLD). At protein position 148, also known as Ile148Met or I148M, the PNPLA3 gene variant linked to NAFLD replaces the amino acid isoleucine with the amino acid methionine. According to studies, the mutated protein causes the liver to produce more fat and break down less of it. Major findings were that the PNPLA3 I148M variant increases susceptibility to the whole spectrum of liver damage related to NAFLD, from steatosis to NASH, fibrosis, and HCC (22, 23). The other variant associated with NAFLD is TM6SF2, TM6SF2 is a critical regulator of cholesterol homeostasis, and TM6SF2 is expressed at the highest levels in the human intestine, the specific biological role of TM6SF2 is not known. Exome-wide association with hepatic triglyceride content in the Dallas Heart Study (DHS) reported that TM6SF2 was the second strongly associated loci with Hepatic Triglycerides Content (HTGC) followed by PNPLA3 (24).

The TM6SF2 genotype associated with HTGC entails the replacement of adenine for guanine at translational nucleotide 499, which results in the substitution of lysine for glutamate at residue 167. The PNPLA3 rs738409 polymorphism did not influence the effect of the Glu167LysTM6SF2 variation on HTGC; there was also no indication of a quantitative interaction between the two risk alleles. The TM6SF2 (rs58542926) variant was not associated with other risk factors for hepatic steatosis, including BMI, homeostatic model assessment-insulin resistance (HOMA-IR), or alcohol intake (25). In recent findings, Some HSD17B13 variations, including rs6834314, and its coupled splicing SNP rs72613567, were attributed to the degree of histological steatosis. The genotypes that are associated with increased hepatic fat are also those that are associated with decreased injury, and the link between injury and steatosis was not reliant on one another (26). In a study, Yanling Ma et al. determined that HSD17B13 is the relevant impacted gene and that rs6834314's correlation with ALT reflects that gene's link with NAFLD. Other research indicated that 17-beta-hydroxysteroid dehydrogenase 13 (HSD17B13) is associated with the clinical outcomes of chronic liver diseases (27). HSD17B13 is mostly expressed in the liver and is mainly in charge of lipid metabolism, which is closely associated with the occurrence and development of chronic liver diseases (28). HSD17B13 expression is increased in the early stages of liver disorders (29), the single nucleotide polymorphisms (SNPs) of HSD17B13, particularly those of the rs72613567: TA allele, have been linked to the course and severity of NAFLD, according to clinical data from several clinical research institutes (30). Recent studies reported when HSD17B13 was more highly





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impressive, it directly and indirectly, played pathogenic roles in the occurrence and development of NAFLD in vitro and in vivo, and thus down-regulating the high expression of HSD17B13 produced a therapeutic effect in NAFLD.

DIAGNOSIS AND SCREENING

NAFLD is asymptomatic, with nonspecific symptoms such as fatigue, abdominal discomfort, and bloating. Liver enzymes are not accurate or stable indicators of NAFLD. However abnormal liver enzymes are frequently found in NAFLD patients (31). 80% of NAFLD patients may have normal liver enzymes (32). The reference standard for diagnosing NAFLD is liver biopsy and histological assessment. Non-Invasive or minimally invasive methods used for diagnosis are as follows, The NAFLD activity score (NAS) is used to diagnose NAFLD, and it has three components: steatosis (Grades 0-3), lobular inflammation (Grades 0-3), and ballooning injury (Grade 0-2), with a grade value of 4 or more indicating NASH. The NAFLD Liver Fat Score (NLFS) assesses the measurement of liver fat content and has demonstrated adequate accuracy in diagnosing NAFLD. It is determined using metabolic syndrome, type 2 diabetes, fasting serum insulin, and the aspartate aminotransferase/alanine aminotransferase ratio in fasting serum (AAR) (33). The Hepatic Steatosis Index (HIS), includes AST/ALT ratio, BMI, diabetes, and gender information. It acts primarily less effectively in diabetic people (34). The Fatty Liver Index (FLI) comprises BMI, waist circumference, and serum levels of triglycerides and gamma-glutamyl transferase (GGT) it has shown good performance in detecting fatty liver, although it has been validated against ultrasonography rather than liver histology (35). Emerging techniques in the diagnosis of NAFLD are, Modern magnetic resonance imaging (MRI) techniques can precisely and consistently detect the proton density fat fraction (PDFF), an objective and quantitative indication of hepatic fat concentration throughout the entire liver (36). A commercial ultrasound-based method called transient elastography (TE) evaluates liver stiffness as a stand-in for hepatic fibrosis. The controlled attenuation parameter (CAP) technique allows for the simultaneous measurement of stiffness and steatosis. Recent studies have revealed that the median CAP is higher in patients with significant steatosis and that it significantly correlates with the percentage of steatosis and the grade of steatosis. A 2012 research (37) showed a significant correlation (r = 0.81) between the degree of steatosis and CAP. Although miRNAs, particularly miR-122 and miR34a, may be regarded as viable diagnostic biomarkers for NAFLD due to their involvement in lipid metabolism, they are still under research

TREATMENTS AND DIETARY RECOMMENDATION

There is reportedly no therapeutic accord for the treatment of NAFLD patients, and lifestyle intervention with a focus on healthy eating, regular physical exercise, and weight loss persists in the management of NAFLD patients. Numerous studies show that altering one's lifestyle can lower aminotransferases and improve hepatic steatosis as determined by ultrasonography (39). Weight loss can regress liver disease, along with the reduction of cardiovascular diseases and T2DM risk. Effective and long-term weight loss has been associated with substantial improvements in glycemic control, hepatic insulin sensitivity, liver enzymes, and liver histology (40). Although patients with NAFLD are typically advised to follow a low-fat diet, current research indicates that a low-carb diet is linked to greater shortterm weight reduction and an improvement in indicators of metabolic syndrome without having any substantial adverse implications (41). Patients who had a higher overall NASH score were more likely to be obese, have higher Insulin Resistance (IR) as determined by HOMA, higher AST, and lower levels of physical activity. Kang et al., enunciate that compared to individuals without metabolic syndrome, people with NAFLD and metabolic syndrome eat more carbs and less fat (42). Abdelmalek et al evaluated the eating habits of 427 NAFLD patients and discovered a correlation between high fructose intake and the severity of fibrosis (43). Fructose does not stimulate insulin secretion, leptin and ghrelin levels are suppressed ultimately contributing to overeating (44). Numerous packaged, processed foods include high fructose corn syrup. Clinical professionals should be aware of excessive carbohydrate consumption and glucose as well as high glucose consumption, which promote the same metabolic endpoint of excessive fatty acid production (45). Small randomized controlled trials (RCTs) and observational studies have repeatedly proven Mediterranean diet is beneficial for people with NAFLD and can also lower liver fat and improve metabolic profile, regardless of weight reduction (46) The Mediterranean diet is distinguished by a high intake of vegetables, legumes, whole grains, olive oil (as the primary source of added fat), fish, shellfish, nuts, and fruits, as well as a reduced intake of red meat, processed meats, and sweets. The polyphenols, carotenoids, oleic acid,





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polyunsaturated fatty acids (PUFAs), and fibre included in the Mediterranean diet are potential molecular explanations underlying the beneficial benefits. These substances could have a positive impact on some liver, adipose tissue, and gastrointestinal pathways, mediating beneficial outcomes in NAFLD (47). In this context, in contradiction to the Mediterranean diet strongly recommending drinking wine in moderation, it is debatable whether NAFLD patients should follow this advice (48). Omega-3 PUFA-rich diets have been found in experimental studies to improve steatohepatitis, lower intra-hepatic triglyceride levels, and boost insulin sensitivity. Another important essential nutrient, choline is a vital component in cell membranes and is essential for the synthesis of phospholipids. A crosssectional investigation revealed that postmenopausal women with low choline consumption had severe fibrosis, while men and women in the premenopausal stage of life also showed a similar pattern. Egg yolks and animal sources of protein are particularly high in choline (49). Another vital aspect of reversing NAFLD is bariatric surgery; the term "bariatric surgery" refers to surgical techniques that result in weight reduction by limiting the quantity of food the stomach can contain and/or by encouraging nutritional malabsorption. Laparoscopic sleeve gastrectomy, laparoscopic Roux-en-Y gastric bypass, laparoscopic adjustable gastric banding, and duodenal switch are the most widely used bariatric surgical treatments in the world. Bariatric surgery can help with insulin resistance, obesity, T2DM, hypertension, dyslipidaemia, and obstructive sleep apnea in addition to a reduction in body weight. It's significant to note that bariatric surgery can significantly improve all histological characteristics of NAFLD, including fibrosis (50).

CONCLUSION

The early identification of high-risk people by the measurement of several biomarkers is critical to the effectiveness of a preventative program. Lifestyle changes, including dietary habits and physical activity, should be the first-line treatment for NAFLD and NASH. Weight reduction >7% is related to clinically significant disease status regression, emphasizing the significance of weight loss in NASH patients. The Western diet has transformed over the course of human development, and it is now noticeably concentrated in saturated and trans fats, omega-6 fatty acids, carbs, and high-energy foods as contrasted to fruits, vegetables, proteins, and omega-3 fatty acids. Individualized dietary advice for NAFLD patients remains largely unexplored, and future studies should emphasize obtaining a thorough understanding of the underlying mechanisms behind food-gene-environment interactions. Considering nutrigenomics as a possibility will assure us that we can put together the melodic mix of nutrients that are appropriate for our genome, composing the ideal health symphony.

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Table 1: Factors Associated with Obesity and NAFLD Development

TYPE OF RISK FACTORS	SPECIFIC RISK FACTORS		
	Adipocyte-, C1q-, and collagen domain-containing (ADIPOQ), Fat mass- and obesity-		
Genetics	associated gene (FTO), Leptin, Insulin-induced gene 2(INISIG2), Melanocortin 4 receptor		
	(MC4R), Parental obesity, and Epigenetic modifications		
Behavioural	Nutrition, eating behaviour, poor dietary choices, high calories, high-fat food,		
	sugar-sweetened beverages, physical inactivity, sedentary lifestyle,		
History	insufficient sleep(<5 hours), stress, and smoking cessation(3 week).		
Socioeconomic	Low income, poverty, low education, unemployment, industrialization, mechanized		
Socioeconomic	transportation, urbanization, and socioeconomic status.		
Environmental	Cultural influences, television watching, fast food restaurants, culture,		
Environmental	social bias, and environmental chemicals.		
Biological	Gut microbiome, viruses, brain-gut axis, prenatal determinants, pregnancy, gestational		
biological	diabetes, menopause, neuroendocrine conditions, medications, and physical disability.		
Psychological	Depression and Anxiety		

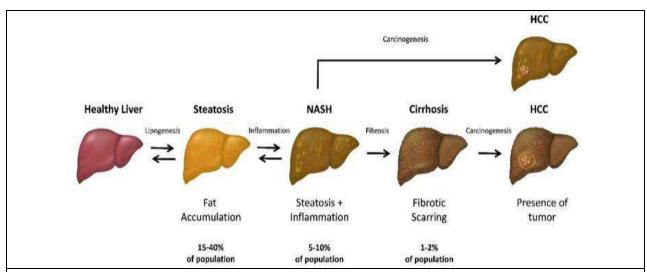


FIGURE 1: THE PROGRESSION AND STAGES OF NAFLD (*ADAPTED from TURCHINOVICH A et al.*)

Figure source-Turchinovich A, Baranova A, Drapkina O, Tonevitsky A. Cell-Free Circulating Nucleic Acids as Early Biomarkers for NAFLD and NAFLD-Associated Disorders.PMID: 30294278; PMCID: PMC6158334.





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RESEARCH ARTICLE

A Value Chain analysis of Banana and its Value added Products in Tiruchirappalli District

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ABSTRACT

Banana is the most popular fresh fruit all over the world and is otherwise called as, "Apple of Paradise". The annual production is estimated to be 45 million tonnes, out of which 20 million tonnes is used as dessert and 25 million tonnes is used as culinary purposes. Annually 6.7 million tonne of banana is being exported. In India, banana is largely grown in Tamil Nadu, Kerala, Maharashtra, Andhra Pradesh and Bihar. Banana production alone constitutes 32 per cent of the fruit production in India. The present study was undertaken to study the value chain of banana sector in Tiruchirapalli district and multi-stage stratified random sampling was adopted for the study. Price spread analysis was worked out and discussed for ten banana value added products, viz., flour, pickle, cookies, chocolates, chewty, dry stem, chips, fibre, yummy Banana and dry Banana fruits and nuts. The primary data is gained through interviews with respondents both farmers and traders. The results showed that the value added products of banana fetched remunerative prices and could be considered as a profitable venture.

Keywords: Value Chain, Price Spread, Value Added Products of Banana.





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INTRODUCTION

Research Background

Banana is a perennial crop that grows quickly and can be harvested all year round. During 2022-23, the world acreage of banana was 60.2 lakh hectares, while the world production was 125.3 million Metric tonnes and productivity was 19.2 Metric tonnes/hectare. The top banana producing nation is inarguably India, which has a year-long production of the fruit. The fruit does not stop growing in certain seasons, unlike other fruits and crops which are limited to certain times of the year. India produces a staggering 30.5million Metric tonnes of bananas each year. The fruit is grown in the Indian states of Gujarat, Assam, Kerala, West Bengal, Madhya Pradesh, Orissa, Karnataka, Tamil Nadu, Maharashtra and Andhra Pradesh. The variety of bananas grown in India includes: Poovan, Nendran, Robusta and Dwarf Cavendish. The major banana growing states are in the northeastern and southern parts of the country. Tamil Nadu has the largest area under banana followed by Maharashtra and Karnataka. Tamil Nadu also ranks first in production, followed by Maharashtra, but the highest productivity is recorded in Maharashtra, followed by Tamil Nadu and Madhya Pradesh. Currently, Tamil Nadu, the leading banana producing state in India, accounts for one third of the country's total banana production.

Area under banana cultivation is on the rise in the state. Currently, Tamil Nadu has about 2.12 lakh acres of banana cultivation. Theni, Trichy, Erode, Thoothukudi, Coimbatore, Kanyakumari, Thanjavur and Dindigul are the prominent regions where the crop is being cultivated. The export market is also opening up an exported 150 containers of banana last year and this year it has already crossed 500 containers. A big chunk of the Tamil Nadu bananas goes to gulf countries. There is a huge demand for the export of Grand Naine banana and other varieties such as Virupakshi, Sirumalai, Rasthali and Red banana on a large scale. Banana yield in Tamil Nadu is much higher than the national average, with 100 Metric tonnes produced per hectare against the national average of 37 Metric tonnes said Minister for Agriculture. Tamil Nadu is the only state which produces over 18 varieties of banana, while many other states produced only four varieties. Government's initiatives like subsidy for drip irrigation, tissue culture and liquid fertilizer were helping the farmers create record production. Moreover, value addition helps the banana farmers to get better returns. Tiruchirappalli based National Research Centre for Banana (NRCB) has so far developed 24 value-added products from banana, scientists from the institute, who are participating in the National Banana Festival at the Agricultural College and Research Institute (AC&RI), said that banana growers could increase their income manifold if they focused on value-added products.

Problem Focus

The non-development of agricultural markets in the state had exposed the farmers to various exploitative trading forces resulting into a situation, where the farmers are unable to get the remunerative prices for their produce. The village level markets are manned by the highest bidding and they do not have the basic facilities for proper marketing. These markets are active only on the appointed days - once or twice in a week and on the appointed days, the sellers and the buyers come to the market for their selling and purchase the bunches. Mostly the small and the marginal farmers and the landless labourers come to the rural market for selling. The grocery shop owners and the local merchants purchase bunches on the following days. But bulk of bunches are purchased by the wholesalers through their commission agents /brokers. The method of sale in force is usually by mutual negotiations often at the advantage of the broker or the commission agents / whole sellers rather than the sellers. In the rural areas, the local merchants and the petty traders also procure bunches from the production sites and sell it in the village auction centers. The banana industry is a very important source of income, employment and export earnings for major banana exporting countries, mainly in developing countries. To cope up with the increasing demand the area of banana cultivation is also expanding. In this situation it is necessary to study the prevailing banana economy in the study area. It was also found that growers face some specific problems in marketing. Hence, it was felt that it would be appropriate to make an in-depth study on banana, with the general objective to examine the marketing aspects of banana and its value added products which would pave way for the development of the same in the study area.





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OBJECTIVES

The specific objectives of this research are:

- 1. To identify the value chain of banana and its value added products in the study area.
- 2. To work out the price spread for banana and its value added products.

RESEARCH METHODOLOGY

Selection of Research Area and Respondents

A multi-stage stratified random sampling procedure was adopted for the study. The district forms the universe and the blocks in the district form the first stage of sampling. The villages in the selected blocks form the second stage and the banana growers and traders in the selected villages form the third and the ultimate unit of the sampling. Banana crop is grown almost in all the districts of Tamil Nadu. Among the districts of Tamil Nadu, Tiruchirappalli district is the major banana producer. Hence, Tiruchirappalli district was purposively selected for the study. The blocks in Tiruchirappalli district were arranged in the descending order of magnitude based on the area under banana, the first block namely Thottiyam was selected and it formed the first stage of sampling. The villages in the selected block were arranged in the descending order of magnitude based on the area under banana and four villages were selected randomly from the block. The sample farmers were selected from these four selected villages at the rate of 10 per village and the ultimate sample farmers was 40. The farmers were contacted individually for collection of details on production, marketing, post production activities, value chain of banana etc., with the help of a well structured and pre-tested interview schedule. The intermediaries involved in value chain of banana namely pre-harvest contractors, local traders, commission agents, wholesalers, processors, exporters and retailers were also considered for the study. A total of 60 sample intermediaries were drawn from the value chain, tracing from the origin, i.e., the farmers.

Nature of Data

Two detailed structured questionnaires were prepared for mapping the entire value chain, one for farmer and another for the intermediaries. The interview schedule was designed, pre-tested and finalized. The data collected were tabulated, processed and subjected to statistical analysis.

Tools of Analysis

The data collected were analyzed and tabulated for subsequent analysis. Keeping this in view the objectives of the study, appropriate tools were employed to analyze the data. The analytical techniques used in the study are mentioned below.

Descriptive Analysis

Descriptive statistical analysis such as mean, percentage, etc., was used for making comparisons of general characteristics of sample farmers, traders and banana processing units and in other analysis wherever necessary.

Mapping the Value Chain

Mapping a value chain eases a clear understanding of the series of activities with main actors and relationships involved. It provided tools and examples on how to capture the different dimensions of a value chain. So, Value Chain Analysis (VCA) began with the process of mapping the value chain. "A picture is worth a thousand words". So, models, figures, diagram and tables were used to understand a value chain. Following dimensions were essential to map and to provide an overview of the banana value chains. Following value chains were identified in the study

- (a) Value chain for banana in local markets.
- (b) Value chain for banana value added products.
- (c) Value chain for banana fibre.





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Price Spread Analysis

For the present study, concurrent margin method is used to analyze the price spread. The price spread analysis involved computation of marketing cost and market margin and their expression as a percentage to the consumer's rupee. Moreover, farmer's share in consumer's rupee was also worked out in the estimation of price spread.

RESULTS AND DISCUSSIONS

With reference to the specific objectives defined for the study, the primary data collected from the sample respondents were analysed. The results are presented here under.

Mapping of Value Chain for Banana and its Value Added Products

The mapping of value chain was done separately for three products, *viz.*, for banana, for banana value added products and for banana fibre.

Mapping of Value Chain for Banana

Value chain mapping activity identifies links in the chain where exchanges are made. Linkages show the activities/roles played by different stakeholders. In Tiruchirappalli markets, the banana bunches are disposed in two major ways. The banana bunches are harvested by the farmers themselves and taken to auction centers, subsequently sold to commission agents or wholesalers. Secondly, bunches are sold out to the pre-harvest contractors by the farmers who further sells it in the banana markets. Hence three predominant value chains were identified for banana in the local markets and is furnished below in Figure 1.

Value Chain for Banana Value Added Products

Thottiyam in Tamil Nadu is a place recognized for its banana cultivation. Hence Thottiyam Banana Producer Association was set up there by carefully selecting 13 progressive farmers. These 13 farmers are the directors of the Association. As of date, Association has 300 banana farmers as its members. Along with the 13 farmer-directors, a company by name Thottiyam Banana Producer Company was formed as a partnership concern with the capital investment of Rs. 20 lakhs along with Rs.8 lakhs worth green house solar drier given as free of cost by Bayer Material Science and German Development Bank. Company purchases ripened fruits from farmers at reasonable price or market price whichever is higher, thereby increasing the revenue of farmers and reducing the loss. The development of this processed banana value chain emerged at crossing of an opportunity and need. Banana, being highly perishable suffers from post-harvest losses to the extent of 25 - 30 per cent during glut seasons. The shelf life of the fresh banana can be extended by storing at low temperature, vacuum packaging and processing into several value added forms like chips, flower pickle, flour, fruit bars, chewty, jelly, banana cookies, banana fruit and nuts, banana chocolates etc. The value chain for banana value added products in furnished in Figure 2. Figure 2 illustrates the value chain for processed banana. It shows that the farmers sell directly to the processing units (to reduce costs) or through local traders. Processing units operate on availability of raw materials at a competitive price. Sometimes, they struggle to get supplies. On marketing, there is a lack of awareness among consumers and in some cases, products gets spoiled due to insufficient market outlets.

Value Chain for Banana Fibre

Banana fibre extracted from its stem (after harvesting banana) has many agricultural and industrial applications. The fiber when used as agricultural input augments the growth of the plant and increases the productivity by many folds. The fibre is extracted from the banana stem using a machine. These machines are manually operated and can run non-stop for 8-9 hours. All varieties of banana can be fed in the machine to extract the fibre. Commonly from one stem 150-200 grams fibre is extracted. In one acre farmland one can approximately procure 1,000-1,500 stems. The fully automatic banana extraction machine is designed to feed the banana stems through the conveyor. Quality and quantity of the fibre produced in this machine shall be finest. It would not need any human intervention. One stem would yield 300 gram fibre. In addition, it has more than 10 industrial applications such as Indian currency, table





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mate, basket, bags, curtain, bed, roofing sheets, bricks, paper, pillow, office files, cloths, use-and –throw vessels etc. The by-products of banana fibre extraction that is pith and sap water are also used in farming. Understanding the contemporary trends and fashion, vendors design these items in the most appealing patterns and designs. These products are known for their attractive look, outstanding performance and unmatched quality, as these are crafted using the premium quality banana fiber. Considering the cost fence of the clients, they offer these products at highly affordable prices. These are recognized for their high strength, eco-friendly nature, purity and durability thus, widely demanded all across the globe. The value chain for banana fibre is given in Figure 3. It is evident that the banana growers sell their produce to processors, which in turn producers the fibre and given to exporters, finally to consumers.

Price Spread Analysis for Banana Value Added Products

The price spread was worked out for ten banana value added products, viz., flour, pickle, cookies, chocolates, chewty, dry stem, chips, fibre, yummy banana and dry banana fruits and nuts. Also, it was noted that the marketing cost incurred by the traders were almost same for all the products of banana. The results are presented in Table 1. The price spread for the manufacture of banana chocolates is given in the above Table 1. It could be observed that the net price received by the banana growers was Rs. 15 per 5 banana (30 per cent). The expenses incurred by processors and dealers were Rs. 15 per five pieces of chocolates (30 per cent) and Rs. 1.50 per five pieces of chocolates (3 per cent), respectively. The marketing margin of the processors and dealers were Rs. 13 (26 per cent) and Rs. 5.50 (11 per cent). The final price paid by the consumers, Rs. 50 per five pieces of chocolates. Out of five bananas, 5 pieces of banana chocolate can be processed. Processors procure banana from banana producers and these are processed in raw banana in the form of banana cookies. It could be inferred that the net price received by the banana growers was Rs. 12 per 4 bananas (34.20 per cent). The expenses incurred by processors and dealers were Rs. 11 per 90 gm (31.45 per cent) and Rs. 1.50 per 90 gm (4.30 per cent), respectively. The marketing margin of the processors and dealers were Rs. 8 (22.85 per cent) and Rs. 2.50 (7.20 per cent). The final price paid by the consumers was Rs. 35 per 90 gm of cookies. Out of four bananas, 90 gm of banana cookies can be processed. From the price spread for the manufacture of banana fruit and nuts, it could be observed that the net price received by the banana growers was Rs. 21 per kg of banana (35 per cent). The expenses incurred by processors and dealers were Rs. 13 per 100 gm (21.66 per cent) and Rs. 1.50 per 100 gm (2.50 per cent), respectively. The marketing margin of the processors and dealers were Rs. 18 (30 per cent) and Rs. 6.50 (10.84 per cent). The final price paid by the consumers was Rs. 60 per 100 gm of dry banana fruits and nuts. Out of one kg banana, 100 gm of dry banana fruits and nuts can be processed. For the manufacture of banana chewty, it could be noted that the net price received by the banana growers was Rs. 20 per kg of banana (33.33 per cent). The expenses incurred by processors and dealers were Rs. 12.50 per 100 gm (20.85 per cent) and Rs. 2.50 per 100 gm (4.16 per cent), respectively. The marketing margin of the processors and dealers were Rs. 17.50 (29.16 per cent) and Rs. 7.50 (12.50 per cent). The final price paid by the consumers was Rs. 60 per 100 gm of banana chewty. Out of one kg banana, 100 gm of banana chewty can be processed.

Processors procure banana from banana producers and these are processed in raw banana in the form of yummy banana. The net price received by the banana growers was Rs. 3 per banana (20 per cent). The expenses incurred by processors and dealers were Rs. 4 per 20 gm (26.66 per cent) and Re. one per 20 gm (6.66 per cent), respectively. The marketing margin of the processors and dealers were Rs. 5 (33.33 per cent) and Rs. 2 (13.55 per cent). The final price paid by the consumers was Rs. 15 per 20 gm of yummy banana. Out of one banana, 20 gm of yummy banana can be processed. In case of banana powder, the net price received by the banana growers was Rs. 15 per half a kg banana (42.85 per cent). The expenses incurred by processors and dealers were Rs. 5 per 100 gm (14.28 per cent) and Rs. 1.50 per 100 gm (4.30 per cent), respectively. The marketing margins of the processors and dealers price were Rs. 10 (28.57 per cent) and Rs. 3.50 (10 per cent). The final price paid by the consumers was Rs. 35 per 100 gm of banana powder. Out of half a kg banana, 100 gm of banana powder can be processed. With regard to banana fibre, the net price received by the banana growers was Rs. 60 per 10 kg banana stem (15 per cent). The expenses incurred by processors and dealers were Rs. 105 per 250 gm (26.25 per cent) and Rs. 35 per 250 gm (8.75 per cent), respectively. The marketing margins of the processors and dealers price were Rs. 135 (33.75 per cent) and Rs. 65 (16.25 per cent). The final price paid by the consumers was Rs. 400 per 250 gm of banana fibre. Out of 10 kg banana stem, 250 gm of





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banana fibre can be processed. For banana flower pickle, the net price received by the banana growers was Rs. 5 per banana flower (9.09 per cent). The expenses incurred by processor and dealers were Rs. 21.50 per 200 gm (39.09 per cent) and Rs. 1.50 per 200 gm (2.72 per cent) respectively. The marketing margins of the processors and dealers price were Rs. 23.50 (42.72 per cent) and Rs. 3.50 (6.38 per cent). The final price paid by the consumers was Rs. 55 per 200 gm of banana flower pickle. Out of one banana flower, 200 gm of banana flower pickle can be processed. It could be observed from Table 1 that the net price received by the banana growers was Rs. 6 per kg of banana stem (30 per cent). The expenses incurred by processors were Rs. 5.50 per 200 gm (27.50 per cent). The marketing margin of processors price were Rs. 8.50 (42.50 per cent). The final price paid by the consumers was Rs. 20 per 200 gm of dry banana stem. Out of one kg of banana stem, 200 gm dried banana stem can be processed. Banana chips are becoming up-scalable as more branded snack food companies enter into this market. Processors procure nendran bananas from banana producers and these are processed in form of chips. The net price received by the banana growers was Rs. 28 per kg of nendran banana (37.33 per cent). The expenses incurred by processors were Rs. 15 per 250 gm (20 per cent), respectively. The marketing margin of the processors price were Rs. 32 (42.67 per cent). The final price paid by the consumers was Rs. 75 per 250 gm of nendran banana chips. Out of one kg nendran banana, 250 gm chips can be processed.

SUMMARY AND CONCLUSIONS

Strategic issues in the banana subsector would require leverage intervention. Some of the policy implications arising from this research study are: Banana farmers are small and marginal types; they do not find it profitable to harvest the crop at periodic intervals, transported to market by themselves considering the costs involved. So, it would be beneficial to organize farmers into clusters that facilitate pooling to constitute sufficient volumes for efficient marketing in domestic markets. Farmers can collectively involve in direct marketing through Farmers' Associations to reduce the length of the value chain and increase profitability, since reduced chain length gained better market efficiency and a higher farmers share of consumer rupee. The value added products of banana fetches remunerative prices and can be considered as a profitable venture. Hence, value addition initiatives by small and medium enterprises can be supported by adequate funds. Simultaneously, promotional activities like trade fairs, banana festivals can conducted regularly to popularise the available processed products to improve consumption patterns

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Table 1. Price Spread Analysis for Banana Value Added Products

S. N		articular s	Banana Chocola tes (Rs/5 piece of chocolat es)	Banana Cookie s (Rs/90g m)	Dry Banana Fruits and Nuts (Rs/100g m)	Banana Chewty (Rs/100g m)	Yum my Banan a (Rs / 20 gm)	Bana na Powd er (Rs/ 100 gm)	Bana na Fiber (Rs / 250 gm)	Bana na Flow er Pickl e (Rs / 200 gm)	Dry Bana na Stem (Rs/ 200 gm)	Nendr an Chips (Rs / 250 gm)
1.	a.	Net price receiv ed by produ cer	15.00 (30.00)	12.00 (34.20)	21.00 (35.00)	20.00 (33.33)	3.00 (20.00)	15.00 (42.85)	60.00 (15.00)	5.00 (9.09)	6.00 (30.00)	28.00 (37.33)
2.	a.	Price paid by proce ssor	15.00	12.00	21.00	20.00	3.00	15.00	60.00	5.00	6.00	28.00
	b.	Expen ses incurr ed by proce ssor (labo ur, trans port cost)	15.00 (30.00)	11.00 (31.45)	13.00 (21.66)	12.50 (20.85)	4.00 (26.66)	5.00 (14.28)	105.0 0 (26.25	21.50 (39.09)	5.50 (27.50)	15.00 (20.00)
	c.	Margi nof proce ssor	13.00 (26.00)	8.00 (22.85)	18.00 (30.00)	17.50 (29.16)	5.00 (33.33)	10.00 (28.57)	135.0 0 (33.75)	23.50 (42.72)	8.50 (42.50)	32.00 (42.67)
3.	a.	Price paid by dealer	43.00	31.00	52.00	50.00	12.00	30.00	300.0 0	50.00	-	-
	b.	Expen ses incurr ed by dealer (labo ur, trans port cost)	1.50 (3.00)	1.50 (4.30)	1.50 (2.50)	2.50 (4.16)	1.00 (6.66)	1.50 (4.30)	35.00 (8.75)	1.50 (2.72)	-	-

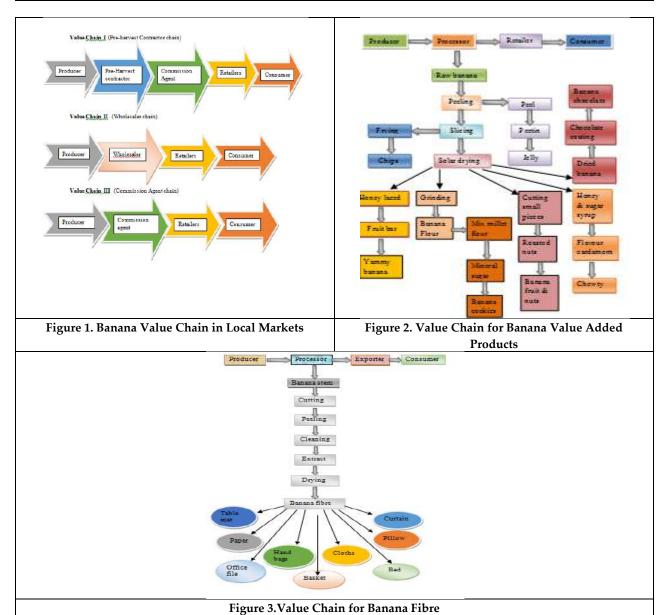




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	c. Mar gin of deal er	5.50 (11.00)	2.50 (7.20)	6.50 (10.84)	7.50 (12.50)	2.00 (13.55)	3.50 (10.00)	65.00 (16.25)	3.50 (6.38)	-	-
4.	Price paid by consumer	50.00 (100.00)	35.00 (100.00)	60.00 (100.00)	60.00 (100.00)	15.00 (100.0 0)	35.00 (100.0 0)	400.0 0 (100.0 0)	55.00 (100.0 0)	20.00 (100.0 0)	75.00 (100.00)







RESEARCH ARTICLE

Multicriteria Decision Making in Performance Evaluation of **Irrigation System**

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ABSTRACT

This study evaluates the performance of five irrigation subsystems using eight distinct criteria. Two Multicriteria decision making (MCDM) methods. Namely, stochastic extension of PROMETHEE - II (STOPROM -2) and multi-Attribute Utility Theory (MAUT) are employed to select the best one among the five irrigation sub systems. The Taguchi methodology is utilized to reduce the computing load that arises during the STOPROM -2 sensitivity analysis research. The suggested approach can be used as a template to select the most effective one for creating policies that will increase the effectiveness and performance of comparable other irrigation subsystems.

Keywords: Analytic Hierarchy Process: Stochastic extension of PROMETHEE -II (STOPROM-2) and multi - Attribute Utility Theory (MAUT), Group Decision - Making, Taguchi - Methodology.

INTRODUCTION

Problem Description and Case Study

Five irrigation subsystems (denoted as D1 to D5) of Arignar Anna Sugar Mills, Marungulam, Thanjavur, TamilNadu, India. (AASM), are evaluated on eight criteria, namely, (1) On - farm development works (2) Adequacy of water (3) Supply of inputs (4) Conjunctive use of water resources (5) Productivity (6) Farmer's participation (7) Economic Impact (8) Social Impact to select suitable irrigation subsystem that can be made a pilot to formulate guidelines so that the efficiency and performance of the other irrigation subsystems can also be improved accordingly. Although there is some correlation between productivity and economic impact, for the purpose of evaluating their impact on





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the overall planning scenario, these are taken to be independent. Brief description of criteria (reprehended by C1 to C8) is presented below.

- C1:On farm development works include land levelling and shaping.
- C2: Adequacy of water refers to having enough water at the appropriate moment..
- C3: Input Supply Inputs like fertilizer, seeds, and bank financing are necessary for efficient irrigation management.
- C4: Coordinated use of water resources crucial for reducing waterlogging impact and offering crops a more dependable supply of water when needed.
- C5: Productivity of various crops for various seasons for various landholdings.
- C6: Farmer's participation is essential for optimum utilization of resources. It is the way in which farmers use the irrigation water that determines the success of an irrigation project.
- C7:Economic Impact Includes farmer's income and revenue collected for supply of irrigation water.
- C8:Social Impact includes labour employment which is measured in terms of Man-days employment per hectare for each crop grown.

Payoff Matrix Formulation

Three officials who are monitoring the project for the last few years are requested to formulate the payoff matrix. They were provided with summarized information; outcome of interview's conducted in the project with farmers and officials. All of the criteria in the current study are taken to All of the criteria used in this study are presumptively subjective. All the above criteria are evaluated against each irrigation subsystem in the form of payoff matrix by each official. The present value of the mean and standard deviation for the three payoff matrices provided by the three officials. Two experts are requested for ranking irrigation subsystems due to their vast experience in metacriterion Decision – Making (MCDM) and allied fields and their acquaintance with the planning problem.

Estimation of Weight of Criteria by Analytic Hierarchy Process

Expert 1was requested to fill in the pairwise comparison matrix based on Saaty's Nine – Point scale. Filled up pairwise comparison matrix as presented in Table III is solved using power method (Saaty and Golbarnejhad, 1982). Maximum eigenvalue (λ_{max}) and Consistency Index (CI) are found to be 6.7236 and 0.0208. Consistency Ratio (CR) which is the ratio of Consistency Index (CI) to Random Index (random index value for matrix size 8 is 0.3952 is 0.012 and found to be less than 0.1 indicating that judgements given by expert 1 are satisfactory. Weight of the criteria, onfarm development works, adequacy of water, supply of inputs, conjunctive use of water resources, productivity, farmer's participation, economic impact, social impact are 0.9174, 0.88,0.9177,0.8217,0.9522,0.7212,0.8375 and 0.1900 respectively and presented in Table III. These are 0.9551,0.9565,0.8999,0.9329,0.7912,0.8491,0.7909 and 0.8244 for expert 2.

RESULTS AND DISCUSSION

Application of STOPROM -II

Expected metacriterion preference index for each (based on his choice, type of preference function, indifference, preference thresholds and weights of the criteria is computed. Table – 4 presents expected metacriterion preference index, \emptyset^+ , \emptyset^- , \emptyset values and corresponding ranking pattern for export I. Irrigation subsystem D1 having highest \emptyset value of 0.0715 occupied the top position Table – 5 presents ranking pattern by STOPROM – 2 for both experts (Mareschal.1986). Sensitivity analysis on the ranking pattern is also conducted for four types of criterion functions (levels), namely, (1) Quasi – criterion, (2) Criterion with linear preference, (3) Level criterion and (4) Criterion with linear preference and indifference area with eight criteria which requires 4^8 (65,536) computational runs to analyze the problem. As there are more criteria, factors, and criterion functions and levels, this number rises dramatically.





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Taguchi methodology (Ross, 2005) is used to minimize the computational complexity arising out of this situation by using OA_{32} orthogonal array. Four hundred eighty combinations resulting from five sets of indifference and preference thresholds for three weight scenarios for 32 computational runs (5 × 3 × 32) are studied as a part of senesitity analysis. These combinations have fallen into seven groups of ranking patterns. The study revealed that ranking pattern is quite robust as far as the first position (irrigation subsystem D_1) is concerned and methodology is found to be useful particu0larly when number of criterion functions / levels is more (Raju, 1995; Raju and Pillai, 1999).

Application of Multi – Attribute Utility Theory.

Multi – Attribute Utility Theory (MAUT) is based on utility theory (keeney and Raiffa, 19765; Keeney and Wood, 1977). The method takes into account the decision-maker's preferences in the form of utility functions which are defined over a set of attributes or criteria. In the present study, it is assumed that (a) axiomatic basis underlying MAUT is approximately satisfied and that there exists a utility function to represent the decision – maker's preference (b) conditions of preferential and utility independence are satisfied (c) multiplicative form of equation is valid for combining single attribute utility functions into a multi – attribute utility function (Raju and Pillai, 1999). The eight criteria used in this study are denoted as C_1toC_8 for representing in equations. The response from two experts is utilized in the analysis to derive the single attribute utility functions and there by multi-attribute utility functions. The various steps to determine the multi – attribute utility function are as follows (Keeney and Raiffa, 1976; Keeney and Wood, 1977).

Ranking of scaling constant (k_i) for the criteria.

The criteria's scaling constants must be prioritized in order of importance. Which of the eight criteria is preferred to be marginally better than the other seven, with the remaining seven remaining at their worst levels, given that all eight are at their lowest points? is the question posed. Suppose the response is "economic impact" then, value of k_1 is greater than $k_1 or k_6$ and k_8 , where $k_1 to k_8$ are scaling constants corresponding to eight criteria $C_1 to C_8$. The procedure is repeated to rank the remaining criteria. The ranking of criteria based on the response form expert 1 is $k_7 > k_5 > k_8 > k_2 > k_4 > k_1 > k_6 > k_3$ whereas for expert 2 it is $k_7 > k_5 > k_8 > k_6 > k_3 > k_4 > k_1 > k_2$. It is observed that similar ranking is obtained when AHP is employed for determining the wights of the criteria and this also confirms the consistency of the experts, while evaluating the priority of the criteria.

Determination of indifference points

By using the concept of an indifference curve, or contours of equal usefulness, the true magnitude of the scaling constants can be determined. For example, for criteria c_7 and c_5 (the two highest ranked criteria), the expert is indifferent between $(c_5 = best, c_7 = worst)andc_5worst c_7 = y)$ where y is some value less than the best value of c_7 while All other criteria are at any fixed level. For the above case are (100, 0), (0, y), Where value of y provided is 90. Similar procedure is adopted for all other pairs. Experts are requested to assume linearity to represent the characteristics that fall in between these values because they may not be represented on the scale. Indifference values for pairs (c_7, c_5) , (c_7, c_8) , (c_7, c_4) , (c_7, c_1) , (c_7, c_5) , (c_7, c_6) , (c_7, c_6) , (c_7, c_3) , obtained from expert I are 89, 69, 64,49,29, 09 whereas indifference values for pair (c_7, c_5) , (c_7, c_6) , (c_7, c_6) , (c_7, c_6) , (c_7, c_4) , (c_7, c_1) , (c_7, c_2) , for expert II are 84,79,69,64,49,29,09.

Shape of the utility function

Modified assessment is proposed, i.e., only defined points on the scale are used to achieve meaningful single attribute utility functions for the subjective criterion. The utility curves for criteria, adequacy of water, supply of inputs, productivity and economic impact are observed to be almost parallel for both the expert's scenario. For the remaining criteria, the curves have been observed to be parallel up to some utility value and thereafter these are crossing each other. Piecewise linear approximation is adopted for the is adopted for the computation of intermediate values of the utility function. Utility curves for eight criteria are presented. The multiplicative form of equation for the eight criteria case becomes with reference to the equation $1 + ku(c_1, c_2,, c_8) = \prod_{i=1}^8 [1 + kk_{iuj} (c_i)] \rightarrow (1)$





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Equating the Utility values of two indifference points (c_7 , c_5) Equation (1) transforms into (for expert1).

$$\left[1 + ^{(worst)}_{kk_7u_7(c_7)}\right] \left[1 + ^{(best)}_{kk_5u_5(c_5)}\right] = \left[1 + ^{(y)}_{kk_7u_7(c_7)}\right] \left[1 + ^{(worst)}_{kk_5u_5(c_5)}\right] \rightarrow (2)$$

$$(1 + kk_7 \times 0)(1 + kk_5 \times 1) = [1 + kk_7 \times u_7(89)][1 + kk_5 \times 0)] \rightarrow (31 + kk_7 = 1 + kk_7u_7(89); k_5 = k_7u_7(89); k_5 = 0.85k_7 \rightarrow (4)$$

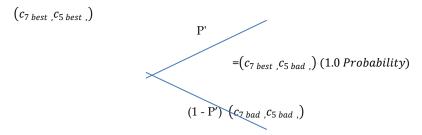
Where c'_5 and c'_7 are difference points for criteria c_5 , c_7), respectively, Similar procedure is adopted for other pairs and the following relationship is obtained.

For pairs

 c_7 and c_8 , $k_8 = 0.575k_7$; c_7 and c_2 , $k_2 = 0.450k_7$; c_7 and $c_{4,1}k_4 = 0.400k_{7,1}$

$$c_7$$
 and c_1 , $k_1 = 0.250k_7$; c_7 and $c_{6,k_6} = 0.175k_7$; c_7 and $c_{3,k_3} = 0.400k_7$; \rightarrow (5)

In the above equations, the total number of unknowns is nine including eight scaling constants $(k_1 to k_8)$ and one overall scaling constant k. A total of seven equations (4) and equations (5) are formulated based on indifference trade-off relationship between the two criteria. One more equation is introduced to assess the overall scaling constant k, by estimating the probability p for which the expert is different between possibility A*over the best and worst combinations of two highly ranked criteria i.e., $(c_{7 best}, c_{5 best})$, $(c_{7 bad}, c_{5 bad})$ versus possibility B*, i.e., $(c_{7 best}, c_{5 bad})$ for criteria.



The multiplicative form of equation (1) for two criteria case becomes

$$1 + ku(c_{7,c_{5}}) = (1 + kk_{7}u_{7}(c_{7,}))(1 + kk_{5}u_{5}(c_{5})) \rightarrow (6)$$

$$u(c_{7,c_{5}}) = \left[\frac{(1 + (1 + kk_{7}u_{7}(c_{7,}))(1 + kk_{5}u_{5}(c_{5})) - 1}{k}\right] \rightarrow (7)$$

Equating the utility values of possibilities, A* and B* for two highly – ranked criterion results in $P'u(c_{7 best}, c_{5 best})$ +

$$(1-P').u(c_{7 bed},c_{5 bed}) = u(c_{7 best},c_{5 best}) \to (8) \text{ where,}$$

$$u(c_{7 best},c_{5 best}) = \left[\frac{(1+kk_7 \times 1)(1+kk_5 \times 1)-1}{k}\right] = k_7 + k_5 + kk_5k_7 \to (9)$$

$$u(c_{7\ bad\ ,}c_{5\ bad\ }) = \left[\frac{(1+kk_7\times 0)(1+kk_5\times \ 0)-1}{k}\right] = 0\ \to (10)$$

$$u(c_{7\ best\ ,}c_{5\ bad}) = \left[\frac{(1+kk_7\times 1)(1+kk_5\times 0-1)}{k}\right] = k_7 \rightarrow (11)$$

Substituting these values, equation (7) results in

$$k_7 = p'(k_7 + k_5 + kk_5k_7) \rightarrow (12)$$

A probability value (p) 0.6 is given by expert 1 and Equation (12) reduced to

$$k_7 = \frac{0.184}{k}$$

If all the criteria are set at their best levels, Equation (1) transforms to

$$1 + k = (1 + kk_1)(1 + kk_2)(1 + kk_3)(1 + kk_4)(1 + kk_5)(1 + kk_6)(1 + kk_7)(1 + kk_8)$$





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Substituting Equation (4), (5), (13) in (14), yields scaling constants for each criterion and overall scaling constant. These 0.88, 0.9177, 0.8217, 0.9522, 0.7212, 0.8375, 0.1900 expert 0.9551,0.9565,0.8999,0.9329,0.7912,0.8491,0.7909 and 0.8244 for experts II respectively. Negative values of scaling constant k indicate risk aversive attitude of the decision - maker. Table 5 presents utility values corresponding to each irrigation subsystem and corresponding ranking pattern (values in parenthesis) for both experts (Raju and Pillai, 1999). For the sensitivity analysis of MAUT, the value of each scaling constant k_i ; j = 1 to 8 is increased and then decreased as much as possible without changing the order k_i . For in second expert's case, k5 is the second largest k_i with a value of 0.4576, the adjacent values are $k_7 = 0.7$ and $k_8 = 0.525$. There fore two sensitivity runs are performed to investigate the influence of k_5 and k_8 values up to 0.588 and 0.415 respectively, which represent the range that maintains the same order and values of the other k_i . Similarly, sensitivity analysis for other values of k_i is performed. A total of 16 combination of scaling constants are evaluated for each expert's case. The analysis indicated that the ranking of the irrigation subsystems remained essentially same as far as the first position (irrigation subsystem D1) is concerned for both the expert's case.

TOPSIS as one of MCDM

Methods considers both the distance of each alternative from the positive ideal and the distance of each alternative from the negative ideal point. In this study there are 4 criteria and 5alternativesthat are ranked based on TOPSIS method. The following table describes the criteria

Characteristics of Criteria Decision Matrix

	CIMILETO OI C					
	name	weight				
1	C1	0.4174				
2	C2	0.38				
3	C3	0.4523				
4	C4	0.4177				

	C1	C2	C3	C4
D1	91.83	85.17	91.83	25.17
D2	58.5	71.83	71.83	11.83
D3	51.83	91.83	65.17	5.17
D4	31.83	45.17	45.17	38.5
D5	51.83	25.17	51.83	65.17

The Steps of the TOPSIS Method

STEP 1: Normalize the decision-matrix.

The following formula can be used to normalize. $r_{ij}(\mathbf{x}) = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}$ $i=1,\ldots,m$; $j=1,\ldots,n$

The following table shows the normalized matrix.

The normalized matrix

	C1	C2	C3	C4
D1	0.68	0.555	0.611	0.311
D2	0.433	0.468	0.478	0.146
D3	0.384	0.599	0.434	0.064
D4	0.236	0.295	0.301	0.476
D5	0.384	0.164	0.345	0.807

STEP 2: Calculate the weighted normalized decision matrix.

According to the following formula, the normalized matrix is multiplied by the weight of the criteria.

 $v_{ij}(x) = w_j r_{ij}(x)$ i = 1, ..., m; j = 1, ..., n

The following table showsthe weighted normalized decision matrix.

The weighted normalized matrix

	1110 ((018110011111111111111111111111111					
	C1	C2	C3	C4		
D1	0.284	0.211	0.276	0.13		
D2	0.181	0.178	0.216	0.061		





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D3	0.16	0.228	0.196	0.027
D4	0.098	0.112	0.136	0.199
D5	0.16	0.062	0.156	0.337

STEP 3: Determine the positive ideal and negative ideal solutions.

The TOPSIS technique aims to determine each alternative's degree of separation from both positive and negative standards. Consequently, the following formulas are used in this stage to determine the positive and negative ideal solutions.

$$A^+ = (v_1^+, v_2^+, \dots, v_n^+)$$

$$A^{-} = (v_{1}^{-}, v_{2}^{-}, ..., v_{n}^{-+})$$

So that

$$v_i^+ = \{ \left(\max v_{ij}(x) \middle| j \in j_1 \right), \left(\min v_{ij}(x) \middle| j \in j_2 \right) \} \ i = 1, \dots, m$$

$$v_i^- = \{ \left(\min v_{ij}(x) \middle| j \in j_1 \right), \left(\max v_{ij}(x) \middle| j \in j_2 \right) \} \ i = 1, \dots, m$$

where j1 and j2 denote the negative and positive criteria, respectively.

The positive and negative ideal values

Distance to positive and negative ideal points

	Positive ideal	Negative ideal
C1	0.284	0.098
C2	0.228	0.062
C3	0.276	0.136
C4	0.337	0.027

	Distance to positive ideal	Distance to negative ideal
D1	0.207	0.295
D2	0.304	0.167
D3	0.343	0.186
D4	0.294	0.179
D5	0.239	0.317

STEP4: distance between the ideal solutions, both positive and negative

TOPSIS method ranks each alternative based on the relative closeness degree to the positive ideal and distance from the negative ideal.

$$d_{i}^{+} = \sqrt{\sum_{j=1}^{n} [v_{ij}(x) - v_{j}^{+}(x)]^{2}} \quad , \quad i = 1, \dots, m \ , d_{i}^{-} = \sqrt{\sum_{j=1}^{n} [v_{ij}(x) - v_{j}^{-}(x)]^{2}} \quad , \quad i = 1, \dots, m$$

STEP 5: Calculate the relative closeness degree of alternatives to the ideal solution

The following formula is used in this stage to determine each alternative's relative degree of closeness to the ideal answer. When the relative closeness degree is close to 1, it indicates that the alternative is farther from the negative ideal solution and closer to the positive ideal solution. $C_i = \frac{d_i^-}{(d_i^+ + d_i^-)}$, i = 1, ..., m

The ci value and ranking The Ci Value

	Ci	rank
D1	0.587	1
D2	0.354	4
D3	0.352	5
D4	0.379	3





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D5	0.57	2

TOPSIS as one of MCDM methods considers both the distance of each alternative from the positive ideal and the distance of each alternative from the negative ideal point.

In this study there are 4 criteria and 5 alternatives that are ranked based on TOPSIS method. The following table describes the criteria.

The following table shows the decision matrix.

Characteristics of Criteria

	name	weight
1	C1	0.3217
2	C2	0.4522
3	C3	0.2212
4	C4	0.3375

Decision Matrix

	C1	C2	C3	C4
D1	0	0.4009	0.2883	0.5911
D2	0.0315	0	0.088	0.2107
D3	0.0432	0.1871	0	0.2379
D4	0.0237	0.0671	0.9273	0
D5	0.0045	0.1556	0.1464	0.2918

The Steps of the TOPSIS

Method

STEP 1: Normalize the decision-matrix.

$$r_{ij}(\mathbf{x}) = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$
 $i = 1, ..., m$; $j = 1, ..., n$

The following table shows the normalized matrix.

The normalized matrix

	C1 C2		C3	C4	
D1	0	0.846	0.292	0.808	
D2	0.537	0	0.089	0.288	
D3	0.737	0.395	0	0.325	
D4	0.404	0.142	0.94	0	
D5	0.077	0.328	0.148	0.399	

STEP 2: Calculate the weighted normalized decision matrix.

The normalized matrix is multiplied by the criteria's weight in accordance with the following formula.

$$v_{ij}(x) = w_i r_{ij}(x)$$
 $i = 1, ..., m$; $j = 1, ..., n$

The weighted normalized matrix

	C1	C2	C3	C4	
D1	0	0.383	0.065	0.273	
D2	0.173	0	0.02	0.097	
D3	0.237	0.179	0	0.11	
D4	0.13	0.064	0.208	0	
D5	0.025	0.149	0.033	0.135	

STEP 3: Determine the positive ideal and negative ideal solutions.

The aim of the TOPSIS method is to calculate the degree of distance of each alternative from positive and negative ideals. Therefore, in this step, the positive and negative ideal solutions are determined according to the following formulas.

$$A^+ = (v_1^+, v_2^+, ..., v_n^+)$$

$$A^{-} = (v_{1}^{-}, v_{2}^{-}, ..., v_{n}^{-+})$$
So that $v_{i}^{+} = \{(\max v_{ij}(x) | j\epsilon j_{1}), (\min v_{ij}(x) | j\epsilon j_{2})\}\ i = 1, ..., m$

 $v_j^- = \{ (\min v_{ij}(x) | j \in j_1), (\max v_{ij}(x) | j \in j_2) \}$ i = 1, ..., mwhere j1 and j2 denote the negative and positive criteria, respectively.





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The following table shows both positive and negative ideal values.

The positive and negative ideal values

	Positive ideal	Negative ideal
C1	0.237	0
C2	0.383	0
C3	0.208	0
C4	0.273	0

STEP4: Distance between positive and negative ideal solutions

TOPSIS method ranks each alternative based on the relative closeness degree to the positive ideal and distance from the negative ideal.

$$d_i^+ = \sqrt{\sum_{j=1}^n [v_{ij}(x) - v_j^+(x)]^2} , i = 1, ..., md_i^- = \sqrt{\sum_{j=1}^n [v_{ij}(x) - v_j^-(x)]^2} , i = 1, ..., m$$

Distance between positive and negative ideal points.

	Distance to positive ideal	Distance to negative ideal
D1	0.277	0.474
D2	0.466	0.199
D3	0.334	0.316
D4	0.433	0.254
D5	0.387	0.205

STEP 5: Calculate the relative closeness degree of alternatives to the ideal solution

In this step, the following formula is used to calculate the relative closeness of each alternative to the ideal answer. If the relative closeness degree is close to one, it indicates that the alternative is closer to the positive ideal solution and further away from the negative ideal solution.

 $C_i = \frac{d_i^-}{(d_i^+ + d_i^-)}$, i = 1, ..., mThe following table shows the relative closeness degree of each alternative to the ideal solution and its ranking.

The ci value and ranking

	Ci	rank
D1	0.631	1
D2	0.453	4
D3	0.387	5
D4	0.469	3
D5	0.546	2

CONCLUSION

The real-world problem involving the application of Multicriteria Decision – Making (MCDM) methods in performance evaluation studies as applied to five irrigation subsystems of the Arignar Anna Sugar Mills, Marungulam, Thanjavur, Tamil Nādu, India. The ranking pattern is quite robust to the criterion function type as far as the first position is concerned in STOPROM – 2 method and Taguchi methodology, and TOPSIS Method is found to be effective to circumvent the computational complexity arising in the sensitivity analysis studies. It is found that the attitude of both the experts is risk aversive as evident from negative value of overall scaling constant R.Economic impact, Productivity and social impact are the three criteria that are given the top priorities by experts. Group





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decision - making concept can be effectively incorporated in the decision-making process using the presently developed methodology.

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Table- I Payoff matrix (mean of three payoff matrices provided by three officials

criteria Irrigation Subsystem	C1	C2	C3	C4	C5	C6	C 7	C8
D1	91.83	85.17	91.83	25.17	85.17	91.83	91.83	91.83
D2	58.50	71.83	71.83	11.83	85.17	65.17	51.83	71.83





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D3	51.83	91.83	65.17	5.17	71.83	31.83	85.17	65.17
D4	31.83	45.17	45.17	38.50	51.83	45.17	71.83	71.83
D5	51.83	25.17	51.83	65.17	85.17	78.50	71.83	71.83

Table- II Standard Deviation Values of Three Payoff Matrices

criteria Irrigation Subsystem	C1	C2	C3	C4	C5	C6	C 7	C8
D1	10.05	10.05	10.05	10.05	10.05	10.05	10.05	10.05
D2	18.50	10.05	10.05	10.05	10.05	10.05	10.05	10.05
D3	21.59	10.05	21.59	10.05	18.50	29.05	10.05	10.05
D4	10.05	10.05	21.59	18.50	10.05	10.05	10.05	10.05
D5	10.05	10.05	21.59	10.05	10.05	18.50	10.05	10.05

Table- III Pairwise comparison of Criteria and weights of criteria (Expert I)

criteria	C1	C2	C3	C4	C5	C6	C7	C8	Weights
C1	1.00	0.40	1.90	0.90	0.40	1.90	0.23	0.40	0.4174
C2	1.90	1.00	1.90	2.50	0.40	1.50	0.23	0.40	0.3800
C3	0.40	0.40	1.00	0.40	0.25	0.90	0.30	0.23	0.4523
C4	0.90	0.23	1.90	1.00	0.23	2.50	0.33	0.40	0.4177
C5	1.90	1.90	3.50	2.50	1.00	2.50	0.40	0.90	0.3217
C6	0.40	0.40	0.90	0.23	0.23	0.90	0.30	0.23	0.4522
C7	2.50	2.50	4.50	2.20	1.90	4.50	0.90	1.90	0.2212
C8	1.90	1.90	2.50	1.90	0.90	2.50	0.40	1.00	0.3375

Table- IV Expected metacriterion preference index, Ø+,Ø-,Ø and ranking pattern by STOPROM – 2(Expert I)

Irrigation Subsystems	D1	D2	D3	D4	D5	Ø ⁺	Ø ⁻	Net Ø	Rank
D1	0.0000	0.4009	0.2883	0.5911	0.3475	0.3892	0.0597	0.3174	1
D2	0.0315	0.0000	0.0880	0.2107	0.1938	0.0810	0.2009	0.0078	4
D3	0.0432	0.1871	0.0000	0.2379	0.1428	0.1275	0.1375	0.0900	5
D4	0.0237	0.0671	0.9273	0.0000	0.0825	0.9991	0.2851	0.1740	3
D5	0.0045	0.1556	0.1464	0.2918	0.0000	0.1270	0.1416	0.0935	2

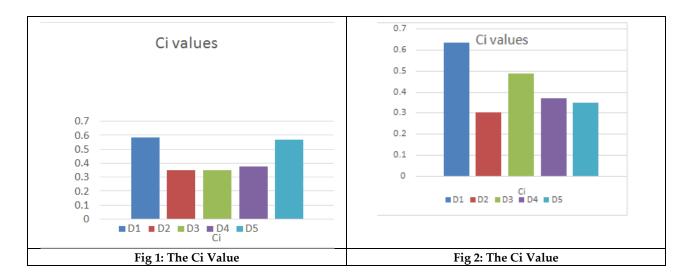
Table- V Ranking pattern obtained by two experts by two methods

	01	-St							
Irrigation	Expert -	I	Expert - 1	II	Group Ranking				
Subsystems	STOPROM-II	MAUT	STOPROM- II	MAUT	Γ Additive Multiplicative I		Final rank		
D1	0.3174 (1)	0.75 (1)	0.3793 (1)	0.88(1)	1	1	1		
D2	0.0078 (4)	0.54(4)	0.0909 (3)	0.82(4)	3.5	3.46	4		
D3	0.9099 (2)	0.58(2)	0.0107 (4)	0.83(3)	3	2.83	5		
D4	0.9035 (5)	0.47(5)	0.2019 (5)	0.80(5)	5	5.00	3		
D5	0.9035 (3)	0.57(3)	0.0433 (2)	0.84(2)	2.5	2.45	2		





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RESEARCH ARTICLE

Enlightening the Role of Varicose Veins Management in the Case of **Knee Osteoarthritis: Case Study**

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ABSTRACT

Knee osteoarthritis is a degenerative joint disease known for disability and health burden on society among the elderly. Primarily it causes knee pain during functional activity. To manage this efficiently author suggested to work on varicose vein / venous insufficiency to get optimal recovery. In this study female patient presented to the outpatient department with a chief complain of both knee and leg pain. She assessed and tailor-made a rehabilitation program was given for 1 month by addressing varicose veins for the management of knee osteoarthritis. This study helps us to understand the role of varicose vein management in the case of knee osteoarthritis.

Keywords: knee osteoarthritis, pneumatic therapy, Varicose vein, venous feeling time

INTRODUCTION

Knee osteoarthritis (KOA) primarily occurs due to the wear and tear process of articular cartilage as a result of ageing. KOA is also known as a progressive joint disorder. (Hsu, H. 2023) Globally KOA is a major reason for disability among the elderly which can increase with obesity. KOA is characterised by functional disability and longterm pain. Up to now, KOA is non-reversible and incurable except for knee replacement which is considered a proven treatment at an advanced stage of the KOA (Bannuru, R. R. et al 2019), however, functional outcomes may be poor and the lifespan of prostheses is limited also it is responsible for extensive health costs. Because of this many researchers have shifted their focus to prevention and management of KOA in its early stage. (Glyn-Jones, S et al 2015) For that, it is needed to understand the modifiable risk factors of KOA for providing effective management strategies in the early stage of KOA. Hence this study has focused on the most neglected modifiable risk factor which is varicose vein, KOA and chronic venous disease/ varicose veins share common risk factors such as obesity and





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prolonged standing. Hence, this study is put forward to set a standard management protocol in the case of KOA by addressing varicose veins.

CASE STUDY

A 52-year-old female presented to our outpatient department with the chief complaint of both knee pain for the past 2 months. She explained to have dull aching pain in her legs which increases with prolonged standing during household activity, prolonged sitting, climbing stairs and walking for more than 1 kilometre at moderate speed. The intensity of this pain, as noted using the Numeric Pain Rating Scale, was 7/10 during her physical activity and 5/10 at rest in her both legs. On observation, we found an antalgic gait with swelling in her legs along with prominent veins in the calf and dorsal foot region. Her cadence (Slaght, J. et al 2017) was reduced to 58 and her Body mass index was calculated to be 34.8 which is obese. On palpation grade 2 tenderness was noted over medial joint space of knee joint and calf region. Hip/knee active range of motion and muscle strength were satisfactory. On the radiological examination, both knee x-rays (standing) were taken and early KOA was diagnosed. The venous filling time (Eberhardt, R. T. et al 2005) was noted to as 13 seconds and clinical observation of enlarged veins suggests varicose veins. Considering all the history and assessment, tailor-made patient-centric management was formulated as shown in Table 1. After obtaining consent from the patient this protocol was given for 1 month with gradual progression in exercises as and when needed. At the end of the program, there is a reduction in the enlarged veins. The knee pain diminished completely and leg pain was reduced to 3/10 during activities and no pain at rest.

DISCUSSIONS

This study was done to establish the importance of considering varicose veins in the management of KOA. In this study first biopsychosocial counselling was given to the patient which included an explanation of the disease in simple understandable terms, the use of various strategies to keep her motivated throughout the process, pain education and the importance of mobility. Ergonomic instructions were given to the patient so that the patient would not endure any aggravation in pain. Since the patient was obese, dietary instructions along with the calory deficit concept were explained to the patient for weight management as obesity is one common risk factor for varicose veins and KOA. Also in obesity, the venous system of the lower extremity has to work harder to pump blood upward and hence higher chances of stasis of blood. (Widyaningsih, T. S. et al 2018) A low-level scanner laser was used on the knee joint and calf region for 10 minutes as it reduces pain and enhances microcirculation by lowering oxidative stressors and biochemical markers. (Dima, R. et al 2018) Active exercises of the hip, knee and ankle were prescribed along with engagement in a social activity like walking with compressive grade 2 stockings till pain allows. Physical activity is needed for efficient venous pumping and to strengthen leg muscles. A coordinated chain of muscular pumps is promoted during walking, and respectively, activating the plantar, calf, thigh, and gluteal pumps so toe walking and heel raises have shown similar effects. (Cataldo, J. L. et al 2012) To improve venous return, leg pneumatic compression is given to the patient for 20 minutes which gives compression to both legs distal to proximally, the patient has also been taught Buerger's exercises for a home exercise program. This leads to the effective functioning of collateral circulation to prevent blood stasis and enhances microvascular endothelial function, which leads to increased venous flow. (Caggiati, A. et al 2018) Management of varicose veins in the lower limbs can improve blood congestion in the lower limbs, which reduces lower limb edema and as a result the load on the muscles of the lower leg. (Oga, Y. et al 2021) Contrast bath was explained to the patient as home advice. Alternate immersion of legs in hot and cold water bucket will promote pumping movement of blood and also help to minimise leg pain. (Higgins, T. R. et al 2017) This study enlightens the relationship between varicose veins and KOA. Varicose veins can disturb the intraosseous microenvironment of the bone. Any alterations in bone perfusion result in hypoxia in the subchondral bone and also cause intraosseous hypertension which increases bone resorption, which is associated with subchondral bone sclerosis and cartilage thinning.(Güneş, S. et al 2020)





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CONCLUSIONS

We investigated the therapeutic effects of varicose vein management in the case of KOA. Varicose veins management in the lower limbs improved knee symptoms in patients whose KOA was not advanced. To the best of our knowledge, there are no published studies in physiotherapy with a clear message to treat varicose veins to get the best outcome for KOA, and hence this study would contribute to enhancing the knowledge of physiotherapists, students and patient awareness.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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Table 1: Physiotherapy intervention program designed for the patient

The real range of the real real real real real real real rea							
GOAL	INTERVENTION						
Biopsychosocial counselling	Pain councelling, Ergonomic advice, motivation, mental imaginary strategies						
weight management	dietary instructions along with the calory deficit concept						
Knee and leg pain	A low-level scanner laser therapy						
Active exercises	Ankle pump, static quadriceps, staright leg raise, heel drag, heel raise, toe walking						
Varicose vein	Pneumatic compression to both leg						
Home exercise program	Burgers exercise , walking with compressive grade 2 stockings to both leg (Till mid thigh)						





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RESEARCH ARTICLE

Optimized Ofloxacin Tablet Formulation for Enhanced Floating Drug **Delivery: A Full Factorial Design**

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ABSTRACT

The objective of this research was to create floating tablets of Ofloxacin for enhanced bioavailability and effectiveness in treating gastro-related conditions. The goals included optimizing the formulation through a 23 full factorial design, evaluating the tablets' physical and chemical characteristics, and determining their stability throughout storage. Gastro-retentive floating tablets of Ofloxacin were formulated by wet granulation, incorporating a blend of neem gum, kappa carrageenan, sodium bicarbonate, citric acid, magnesium stearate, talc, and PVP K30. Drug-excipient interactions were examined using FT-IR studies, while both pre- and post-compression parameters were evaluated. A 23 full factorial design was utilized to optimize the formulation, with floating lag time and in-vitro drug release serving as independent variables, and sodium bicarbonate, dibasic calcium phosphate, neem gum, and





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kappa carrageenan acting as dependent variables. The optimized formulation was determined based on floating lag time and in-vitro drug release. Accelerated stability studies, conducted over 3 months following ICH guidelines, were employed to assess the stability of the optimized formulation. FT-IR studies indicated no chemical interaction between Ofloxacin and the excipients. Both pre- and post-compression parameters of the tablets complied with pharmacopoeial standards. Utilizing the 2³ full factorial design for optimization led to a final formulation comprising 80 mg of sodium bicarbonate and 55 mg of dibasic calcium phosphate. This optimized formulation demonstrated a floating lag time of 29.3 seconds and achieved a 96.26% in-vitro drug release over 11 hours. Accelerated stability studies conducted over a span of 3 months affirmed the stability of the optimized formulation, aligning with ICH guidelines. The optimized gastro retentive floating tablets of Ofloxacin exhibited stable formulation and prolonged drug release, demonstrating potential for enhanced therapeutic efficacy in urinary tract and skin infections.

Keywords: floating tablets, natural polymers, neem gum, kappa carrageenan, Ofloxacin.

INTRODUCTION

The absorption of oral medications varies due to gastrointestinal tract (GIT) conditions, necessitating specialized drug delivery systems to target specific absorption sites. Factors like gastric pH and enzyme activity impact medication stability and solubility. Certain drugs, like narrow absorption window (NAW) drugs, are only active in specific GIT regions. Different absorption routes exist, with the transcellular route being primary. Environmental factors like stomach pH, mucus thickness, bacterial diversity, and drug residence period influence absorption. Oral medicine forms are increasingly needed for chronic disorders[1-3]. Ofloxacin, an antibacterial antibiotic, inhibits bacterial enzymes responsible for DNA coiling. Its solubility is pH-dependent, and it prevents bacterial cell repair. A controlled/sustained release system for ofloxacin was developed to release it in the upper GIT acidic environment for prolonged action. Fluoroquinolones like ofloxacin precipitate at neutral pH, affecting absorption. Utilizing natural gums and mucilage offers advantages over synthetics due to cost-effectiveness, biocompatibility, and stability in various pharmaceutical and industrial applications[4-5]. A factorial design approach optimized the gastroprotective controlled/sustained release system for ofloxacin. This method simultaneously evaluates multiple variables and their interactions to identify factors influencing drug release in the upper GIT. Varying polymer concentration, drug-topolymer ratio, and processing parameters aimed to develop a formulation achieving prolonged release while ensuring stability and bioavailability. This approach enhances understanding of formulation performance and facilitates effective oral medication for bacterial infections [6].

MATERIALS AND METHODS

MATERIALS

Ofloxacin was procured from Empree medicaments, Belgavi, Karnataka. Neem gum and Kappa Carrageenan was obtained from Neonatric DCBA, Coimbatore, Tamil Nadu, Sodium bicarbonate, Citric acid and Magnesium stearate, Dibasic Calcium Phosphate, Talc and PVP K30 were purchased from S.D fine chem Ltd.

Determination of λ_{max} of ofloxacin and preparation of calibration curve

The λ max of ofloxacin was determined to be 294 nm, chosen for its optimal sensitivity in UV spectrum absorbance. Solutions of ofloxacin ranging from 2 to 12 μ g/ml were prepared to establish the standard calibration curve[7]. Absorbance measurements were performed at λ max (294 nm) using a UV spectrometer. Linear regression analysis of concentration against absorbance yielded a calibration curve with R² = 0.995, providing reliable quantification of ofloxacin within the specified concentration range [3,6].





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Drug-excipient compatibility study

IR spectra of pure ofloxacin were compared with a reference standard and the formulated tablet to assess drug-excipient compatibility using FT-IR spectroscopy [7,8] (Shimadzu, Japan) across 4000-400 cm⁻¹.

Formulation design using 23 full factorial design model

Formulation was designed by using Design Expert v.13 by considering the following design and level of factors shown in Table I Independent variables are Sodiumbi carbonate and Dibasic calcium phosphate Dependent variables are *In-vitro* Dissolution and Floating lag time

Formulation of of loxacin floating tablets

The research utilized wet granulation method to formulate eight different formulations of ofloxacin (200 mg) tablets. Design Expert Software aided in designing these formulations with varying concentrations [8-11]. The formulations were prepared by geometrically blending all excipients except the granulating agent, glidants, and lubricants in a mortar and pestle for 15 minutes. Granules were then prepared using PVP K30 and isopropyl alcohol, followed by drying at 60° C for 30 minutes and sieving through no.16 sieve. After drying, the granules were passed through no.22/44 sieve before adding glidants and lubricants. Tablets were compressed using 8mm flat round punches on a single punch tablet machine. The composition of the 200 mg ofloxacin tablet is listed in Table II.

Evaluation of ofloxacin floating tablets

Pre-compression parameters encompassed the examination of flow properties and compressibility of lubricated granules, which involved assessing various measurements including the angle of repose, bulk and tapped density, Hausner's ratio, and compressibility index. Post-compression parameters involved evaluating tablet characteristics such as thickness, hardness, weight variation, friability, drug content, and conducting in-vitro dissolution studies focusing on floating behavior, buoyancy, swelling index, and release kinetics[3,9].

Floating lag time

The floating lag time was determined by visually observing the tablets' floating behavior. A tablet was placed in a glass beaker containing 200 ml of 0.1 N HCl solution maintained at a temperature of 37 ± 0.5 °C in a water bath.

data analysis for controlled release floating tablet of ofloxacin

The data analysis for controlled release floating tablets of Ofloxacin utilized PCP Disso v2 software to fit release data into various kinetic models. Zero-order kinetics, representing pharmaceutical dosage forms with slow disintegration, was analyzed with the equation[10].

 $Qt = Q_0 + K_0^t.$

First-order kinetics, examining release rate, was assessed using Log Qt = log Q0 + K1 t/2.303. The Higuchi model, investigating release from water-soluble or poorly soluble drugs in solid matrices, employed the equation[11]. Qt = $KH.t\frac{1}{2}$.

The Krosmeyer and Peppas release model was utilized to analyze the release rate data, employing a specific equation for this purpose[12].

 $Mt/M \infty = K \times tn$.

These analyses provided crucial insights into the release mechanisms and kinetics of the formulations, aiding in understanding their efficacy and performance.

RESULTS AND DISCUSSIONS

Compatibility studies

IR spectroscopy confirmed compatibility between ofloxacin and excipients, with no significant shifts in drug peaks. Neem gum and kappa carrageenan peaks resembled those of the drug, indicating component compatibility shown in Figure 1 [8-9].





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Pre-compression parameters

Angle of repose: Angle of repose, determined by funnel method, ranged from 24 to 32 degrees, indicating good flow properties^[9,11].

Bulk Density: Bulk density values fell between 0.42 to 0.51g/ml, also signifying good flow.

Tapped Density: Tapped density, measured by the cylinder method, ranged from 0.47 to 0.52 g/ml.

Carr's Index: Carr's index values ranged from 5.19 to 10.38, suggesting good compressibility and flow

Hausner's Ratio: Hausner's ratio values, ranging from 1.05 to 1.21, supported excellent flow properties. All the pre compression parameter values are depicted in Table III

Post compression parameters

Weight Variation: The collective weight range of the tablets was recorded as falling between 0.501 and 0.502 grams, indicating consistent weight variation across the sample set. [12-15]. All the post compression parameter values are depicted in Table IV.

Thickness: The values ranged from 4.16 to 4.34 mm.

Hardness: The hardness was determined by Monsanto hardness tester. The values were 4.6 to 5.3 kg/cm3.

Friability: The friability values for the formulation were found to be in range of 0.468 to 0.643.

Floating Lag Time: floating lag time for formulations were found to be in range of 25 to 180 sec[16].

Drug Content

Drug content for compression-coated tablets was assessed by finely powdering ten tablets. The equivalent of one tablet's weight of Ofloxacin was dissolved in 0.1N HCl and diluted to volume. Absorbance was measured using a UV-Visible spectrophotometer, with results ranging from 97.02% to 98.89% [17-19].

In-vitro dissolution: In-vitro Dissolution Analysis

Formulations F2, F3, F6, and F8, with varying neem gum amounts, showed drug release percentages of 89.04%, 83.86%, 75.25%, and 86.4% respectively over 10-11 hours. For formulations F1, F4, F5, and F7, containing different kappa carrageenan levels, drug release percentages were 96.26%, 92.27%, 96.66%, and 95.67% respectively over 11 hours. The kappa carrageenan formulations exhibited the highest drug release, attributed to its superior swelling property. Floating lag times ranged from 1-2 minutes for all formulations. Cumulative drug release data is presented in Figure 2 [6,10,14].

Kinetic Analysis of Drug Release

Zero Order Model: Formulation F2 demonstrated the closest fit to the Zero Order model (R2=0.9443).

First Order Model: Formulation F5 displayed the strongest adherence to the First Order model (R2=0.9526).

Higuchi Model: Formulations F3 and F4 exhibited notable conformity to the Higuchi model (R2=0.981 and 0.9717 respectively), suggesting diffusion-controlled release.

Korsmeyer-Peppas Model: Formulation F8 demonstrates the highest fit (R2=0.9689), suggesting involvement of both diffusion and polymer relaxation.

Hixson-Crowell Model: Formulations F1 and F6 display high fit (R2=0.9738 and 0.9807 respectively), suggesting particle size reduction^[20].

Statistical Analysis

The analysis of floating lag time involved several statistical measures:

Fit Statistics: The model's fit statistics, including Predicted R^2 , Adjusted R^2 , and Adeq Precision, suggest a good fit for the model, with an adequate signal-to-noise ratio shown in Table V

Coefficients Terms Coded Factors: Coefficient estimates were provided for factors affecting floating lag time. The absence of multicollinearity issues was indicated by Variance Inflation Factors (VIFs) of 1.Coefficientstermscodedfactors is shown in Table V[21].





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Anova For Linear Model: The ANOVA results indicated the significance of the model (p-value = 0.0051), suggesting a low probability of obtaining such a substantial F-value by chance alone. The ANOVA for the linear model, specifically focusing on Response 1 (Floating lag time), was detailed in Table VI.

coefficients Terms Coded Factors: Further coefficient estimates for coded factors were provided, indicating the expected change in response per unit change in factor value, with confidence intervals. In summary, the statistical analysis indicates a noteworthy influence of factors on floating lag time, affirming the reliability of the model's predictions.

Effect Of Factors On Floating Lag Time In Neem Gum Formulations: In formulations containing kappa carrageenan as the release retardant: Increasing NaHCO3 concentration (factor A) decreases floating lag time and Increasing dibasic calcium phosphate concentration (factor B) slightly increases floating lag time. Where the 3D plot of graph of effect of factors A and B on floating lag time and in-vitro drug release containingKappacarrageenan shown in Figure 3 and Figure 5. Similarly, in formulations containing neem gum as the release retardant: Increasing NaHCO3 concentration (factor A) decreases floating lag time and Increasing dibasic calcium phosphate concentration (factor B) also results in a slight increase in floating lag time. These trends were visualized through 3D surface plots (Figure 4 and Figure 6), illustrating the effects of NaHCO3 and dibasic calcium phosphate concentrations on floating lag time and *in-vitro* drug release in neem gum formulations^[11-15].

Overlay Plot Analysis

An overlay plot was generated to illustrate the relationship between the dependent variables (floating lag time and in-vitro drug release) and the independent variables (NaHCO3 and dibasic calcium phosphate) in formulations containing neem gum and kappa carrageenan[22]. The response surface plot depicted the impact of NaHCO3 and dibasic calcium phosphate on floating lag time and in-vitro drug release. Defined limits were set for floating lag time (25 sec to 60 sec) and in-vitro drug release (75.21% to 96.66%). The optimized formulation within the design space adhered to these limits shown in Figure 7. In the design space, the yellow region represents formulations with kappa carrageenan, meeting the specified limits, while the grey region represents neem gum formulations exceeding the limits. This analysis provides insights into the effects of NaHCO3 and dibasic calcium phosphate on the performance of formulations containing neem gum and kappa carrageenan and pre-compression and post-compression parameters for optimized formulation is shown in TableVII.

Accelerated Stability Study

After subjecting the tablets to accelerated stability conditions ($40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and $75\% \pm 5\%$ RH) for three months, no significant changes were observed in the in-vitro dissolution study, floating lag time, total floating time, release characteristics, or physical-chemical properties of the tablets.It can be reasonably concluded that the formulated floating tablets remain stable under these conditions. However, to definitively establish the product's shelf-life, additional studies in accordance with ICH guidelines are necessary [22].

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Table 1: 2³ Level Factorial Design for Floating Tablets

In domandant was ablactic store)	levels				
Independent variables(factors)	low	High			
Factor1:					
Sodiumbicarbonate	70	80			
Factor2:					
Dibasiccalciumphosphate	45	55			





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Factor3:
NeemgumKappacarrageenan
Categorical factor

Table 2: Formulation Table of Floating Tablets of Ofloxacin

CNO	Ingredients]	FORM	IULA7	TION	CODE	3	
S.NO	.NO mg/tab		F2	F3	F4	F5	F6	F7	F8
1	Ofloxacin	200	200	200	200	200	200	200	200
2	Neem gum		110	120			110		100
3	Kappa carrageenan	110			120	100		110	
4	NaHCO ₃	80	70	70	70	80	80	70	80
5	Citric acid	20	20	20	20	20	20	20	20
6	Dibasic calcium phosphate	45	55	45	45	55	45	55	55
7	Talc	10	10	10	10	10	10	10	10
8	Mg. stearate	10	10	10	10	10	10	10	10
9	PVP K30	25	25	25	25	25	25	25	25
	Total	500	500	500	500	500	500	500	500

^{*(}mg-milligram)

Table 3: Pre-Compression Parameters

Formulation code	Angle of repose (degree)	Bulk density (gm/ml)	Tapped density (gm/ml)	Carr's index (%)	Hausner's ratio
F1	27.45±0.02	0.45±0.003	0.47±0.002	9.86±0.04	1.10±0.0005
F2	30.35±0.02	0.42±0.005	0.54±0.007	10.11±0.005	1.21±0.081
F3	24.76±0.05	0.51±0.005	0.50±0.009	9.84±1.28	1.11±0.011
F4	28.92±0.01	0.44±0.005	0.49±0.005	8.39±2.17	1.09±0.036
F5	31.66±0.06	0.44±0.005	0.49±0.011	9.52±1.17	1.10±0.013
F6	32.62±0.01	0.47±0.004	0.51±0.005	8.3±0.89	1.090±0.01
F7	30.54±0.005	0.46±0.008	0.52±0.009	10.38±1.66	1.11±0.020
F8	28.68±0.20	0.48±0.004	0.50±0.005	5.19±0.16	1.05±0.001

^{*(}gm/ml-gram per ml)

Table 4: Post-Compression Parameters

code	Weight variation	Thickness	Hardness	Friability	Floating lag time	Drug content	FT (h)	S.I (±	%CDR (10Hrs)
	(mg)	(mm)	(kg/cm³)	(%)	(sec)	(%)	` ′	SD)	(/
F1	0.501±0.001	4.16±0.152	5.1±0.1	0.498±0.001	25±1	98.31±1.48	>10	40.66	88.12
F2	0.501±0.005	4.16±0.138	4.6±0.15	0.643±0.0005	180±2.88	98.89±0.44	>7	29.85	89.04





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F3	0.501±0.001	4.34±0.092	4.8±0.28	0.527±0.0005	180±5.77	97.02±0.15	>10	32.03	72.64
F4	0.501±0.005	4.11±0.005	5.1±0.15	0.468±0.0005	109±1.15	97.88±1.14	>10	53.33	85.55
F5	0.502±0.005	4.25±0.026	5.5±0.5	0.497±0.0005	57±0.577	97.99±0.47	>10	46.78	98.23
F6	0.501±0.005	4.23±0.015	4.8±0.28	0.497±0.0005	165±2	97.96±0.28	>10	40.69	70.21
F7	0.502±0.001	4.22±0.020	4.8±0.28	0.498±0.0005	107±0.577	97.62±1.19	>10	48.69	90.04
F8	0.501±0.001	4.14±0.121	5.3±0.28	0.498±0.001	120±0.57	97.36±0.92	>10	27.08	86.4

^{*(}FLT-floating lag time, S.I-swelling index,%CDR- Cumulative Drug Release) *(mm-millimeters, kg/cm 2 -kilogram per Square Centimeter, %-percent, s-seconds, %w/w- percent weight by weight, Hrs-Hours)*

Table 5: Fit Statistics for Floating Lag Time and Coefficients Terms Coded Factors

FIT STATISTICS FOR FLOATING LAG TIME								
StdDEV		17.19	R^2		0.9497			
	Mean	117.88	Adjusted	R ²	0.9080			
C.V.%		14.58	Predicted	\mathbb{R}^2	0.789	7		
			AdeqPredic	ction	13.0630			
COEFFICIENTS TERMS CODED FACTORS								
Factor	Coefficientestimate	Degree of freedom	Standarderror	95%CI		VIF		
1 4401		Degree of freedom	Startauraciror	Low	High	• • • • • • • • • • • • • • • • • • • •		
Intercept	117.88	1	6.08	101.00	134.75	1.0000		
A-NaHCO3	-26.13	1	6.08	-43.00	-9.25	1.0000		
B-DCP	-9.88	1	6.08 -26.75 7.0		7.00	1.0000		
C-POLYMER	-43.38	1	6.08	-60.25	-26.50	1.0000		

^{*(}Std DEV- Standard deviation, C.V-Coefficient of Variation CI-Confidence Interval, VIF-Variance Inflation Factor)

Table 6: Anova for Linear Model

RESPONSE 1: FLOATING LAG TIME							
Source	Sum of squares	DF	Mean square	F-value	p-value		
Model	Model 2129.38 3		7097.13	24.03	0.0051		
A-NaHCO3	5460.13	1	5460.13	18.49	18.49		





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95.886

94.1284

99.066

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B-DCP		780.13	1	780.13		2.64		:	2.64	
C-Poly	mer	15051.13 1 1505		15051	1.13	50.96			5	50.96
Resid	ual	1181.50	4	295.	295.37					
Corto	tal	22472.88	7							
	I	RESPONSE 2: IN-	VITRO D	ISSOLUT	ION					
Analysis	Predicted mean	Predicted median	Std.Dev	n	Predicted	d SE	95% PIlow	Data 1	Mean	95%PI
Floatinglag time	38.5	38.5	17.1865	3	15.689	9 .	.05975	20	6	82.0597

0.176777

3

0.19432

96.5975

Table7: Pre-Compression and Post- Compression Parameters for Optimized Formulation.

96.5975

Parameters	values
Angleofrepose(degree)	27.8±0.02
Bulkdensity(gm/cm ³)	0.44±0.005
Tappeddensity(gm/cm³)	0.50±0.009
Carr'sindex	9.52±1.17
Hausner'sratio	1.090±0.01
Weightvariation(mg)	0.501±0.001
Thickness(mm)	4.23±0.015
Hardness(kg/cm³)	5.1±0.15
Friability(%)	0.468±0.0005
Floatinglagtime(seconds)	29.3±0.001
Drugcontent(%)	97.96±0.28
Totalfloatingtime(hours)	11hrs.
Swellingindex(±SD)	46.78
<i>In-vitro</i> drugrelease	96.26%

In-vitro drug release



^{*(}DF-Degree of freedom, SE.-Standard Error PI-Predicted Interval)



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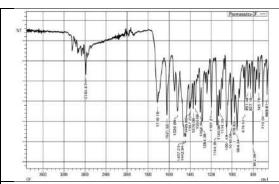


Figure 1: FTIR spectrum of Ofloxacin

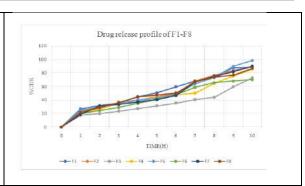


Figure 2: Cumulative % drug release profile of formulation F1 –F8

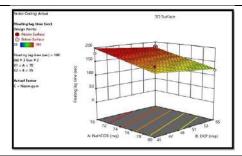


Figure 3: 3D plot of graph of effect of factors A and Bon floating lag time containing neemgum(C)formulation

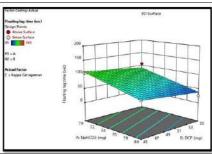


Figure 4: 3D plot of graph of effect of factors A and B on floating lag time containing Kappacarrageenan.

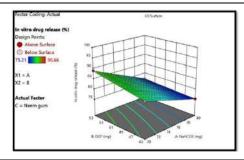


Figure5:3D plot of graph of effect of factors A and B on *in-vitro* drug release containing neemgum (C) formulation.

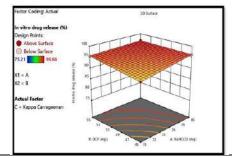


Figure 6:3D plot of graph of effect of factors A and Bon *in-vitro* drug release containing kappacarrageenan(C) formulation.

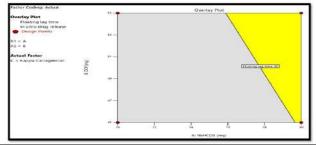


Figure7:3D Over lay plot for floating lag time and in-vitro drug release





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RESEARCH ARTICLE

Fish Diversity and Distribution Patterns in Bharathapuzha River, Kerala

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ABSTRACT

This study was conducted to record fish diversity associated with Bharathapuzha River, from two different locations: Nhangattiri and Velliyamkallu, Thrissur district of Kerala. The study was conducted from December 2020 to May 2021. A total of 20 species of fishes belonging to 8 orders were identified which is an indication of the fact that the habitat is suitable for their existence. The species are Pseudetroplus maculatus, Channa striata, Channa marulius, Oreochromis mossambicus, Pseudosphromenus cupanus, Megalops cyprinoides, Garra mullya, Aplochielus lineatus, Mystus montanus, Devario malabaricus, Heteropneustes fossilis, Wallago attu, Pethia punctata, Dawkensia filamentosa, Anabas testudineus, Clarias gariepinus, Garra stenorhyncus, Mastacembelus armatus and Parambassis thomassi. Two exotic fishes Clarias gariepinus and Oreochromis mossambicus were identified in the study area. Alpha diversity (Dominance, Shannon, Simpson, Evenness, Margalef and Fisher alpha) and Beta diversity indices were calculated. The homogeneity of distribution in different species and different months were statistically analyzed.

Keywords: Bharathapuzha River, Fish diversity, biodiversity indices

INTRODUCTION

The Bharathapuzha River also known as 'Nila' and 'Periyar' originates from the northern and southern lips of the Palakkad gap in the Western Ghats as well as from the gap. The minor tributaries join together to form four major tributaries: Gayathripuzha, Chitturpuzha, Kalpathipuzha and Thoothapuzha. It is the second largest (209 km) and largest (annual discharge of 3.94 km³). Among the west flowing perennial rivers in the state of Kerala (Raj and Azeez





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2012) as well as the river with the most extensive basin area, second in length and third in yield by thousand million cubic feet (TMCF 10° 25-11° 15¹N and 75° 50¹-76° 55¹E) and is located in Palakkad, Thrissur and Malappuram districts of Kerala state. Bharathapuzha has a total basin area of 6,186 km² of which 4,400km² is in Kerala and the remaining in Tamil nadu (Raj & Azeez, 2012). Information on diversity and distribution of species is crucial for appropriate and timely decision making in biodiversity conservation, collection and dissemination of such information is especially important for poorly known yet threatened taxa such as freshwater fish and for critical biodiversity areas. The earliest icthyological investigations in the Bharathapuzha drainage (then Ponnani drainage of erstwhile Malabar state in India) were carried out by Jerdon (1849) and Day (1865). The Western Ghats part of the Western Ghats -Sri Lanka Biodiversity hotspot in peninsular India is an exceptional region of freshwater biodiversity. Bharathapuzha is considered as one of the richest source of aquatic biodiversity including fish, molluscs and odonates. About 116 species of fishes has so far been reported from Bharathapuzha with three species of fishes being endemic to the river. Among the fishes studied, 33 species were found to be endemic to the Western Ghats. About 12 % of the fishes of the Bharathapuzha are considered as threatened. Through the entire course of Bharathapuzha has been interrupted with 13 irrigation projects and regulator cum bridge for drinking water purpose. There are at least 6 non-native fish species in Nila. The contribution of non-native species to the total fishery of Bharathapuzha River was estimated to be 13.93% Indian major carps and Oreochromis mossambicus were the non-native species represented in the exploited fishery. While 3 of them are non-native to Indian rivers 3 are from the Gangetic plains. Though the Indian major carps were introduced as part of aquaculture , considered as a success, the study was able to spot them from lower reaches of the river, revealing that they have proliferated though the river beyond their actual reservoirs. Such proliferation of non-native species often wipes out native species in the fight for resources.

Species foreign to India like Nile Tilapia and Mozambique Tilapia were also spotted from Nila, showing that the alien invasion is possibly stilting the endemic fish fauna of the river. However the surprise factor was that the study reportedly failed to the fetch another notorious alien species-African catfish-which is a known diversity killer in Western Ghats Rivers. Fish diversity comprises of species richness (number of species in defined area), species abundance (relative number of species) and phylogenetic diversity (relationship between different groups of species. Today fish diversity and associated habitat management is a great challenge and the ability to evaluate the effects of habitat and other impacts on the fish population required extensive surveying of the fish population before and after the change occur. Several anthropogenic stresses including deforestation and loss of riparian cover, dams and other impoundments, pollution, sand mining, non-native species and destructive fishing practices and threatening the rich of Ichthyofaunal diversity and endemism in the Bharathapuzha river. Low availability of water in the catchment area disrupts the groundwater recharge and water flow in summer months. Water scarcity is mainly due to loss of forest cover, rain water runoff, sand mining reclamation of wetlands and paddy fields. The present study aimed to document fish diversity in the Bharathapuzha River and to evaluate the diversity indices alpha diversity (Simpson, Dominance, Shannon, Margalef, Fisher alpha) and beta diversity for which two selected sites. Bijukumar et. al., (2001) studied the fisheries of river Bharathapuzha, and their diversity, distribution, threats and conservation. Pereira (2018) studied the native and exotic ichthyodiversity status and pesticide level in Bharathapuzha, Periyar and Pamba as part of the assessment of impact of flood and landslide on biodiversity in comparison to pre-flood scenario. Arun (1998) pointed status and distribution of fishes in Periyar lake stream system of Southern Western Ghats. Kurup, et. al., (2014) studied the biodiversity status of fishes inhabiting rivers of Kerala (S. India) with special reference to endemism threats and conservation measures. Bijukumar and Sushama (2001) studied the fish fauna of Bharathapuzha. Jerdon (1849) described the freshwater fishes of Southern India including Bharathapuzha. The distribution pattern of endemic as well as exotic species has varied much following the recent floods that has occurred in Kerala and this signifies the importance of the present study.

MATERIALS AND METHODS

Fish samples were collected during the early morning using cast net and gillnet. The captured specimens were preserved in 10 % formaldehyde solution. Two sites Nhangattiri and Velliyamkallu in the Bharathapuzha River were





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selected for studying the fish diversity for a period of six months (December 2020-May 2021). During the survey of fishes in Bharathapuzha River before the fishing operation, discussions were made with the fishermen in and around the area. The changes in the river flow, availability of fishes and availability of new species in the river were investigated. Various devices were used for the collection includes bait, drag nets, gill nets and cast nets. The areas were water is clean and transparent enough to observe the fishes from outside, simple observation method was also used for the assessment of fishes. Details regarding the locally available species of fishes were taken from them. Large sized fishes were not captured, but their photographs were taken for the further study and identification. The specimens were identified with the help of taxonomic plates. ANOVA and t test were done for both stations. The diversity indices Dominance, Simpson, Shannon, Evenness, Margalef and Fisher alpha were calculated using suitable formula and PAST software.

RESULTS AND DISCUSSIONS

From Table 1. and Figure 1, it is clear that there is a homogeneity in the distribution of each species of fish at the month of December, January and February. Similarly, the distribution of each species of fish at the month of March, April and May.

Consider the hypothesis

Ho: The distribution of each species of fish at the month of December, January and February are homogeneous.

Hi: The distribution of each species of fish at the month of December, January and Februaryare not homogeneous.

Here the p- value = 0.8905 and α = 0.05, so it is so clear that the distribution of each species of fish at the month of December, January and February are homogeneous. Also, consider

Ho: The distribution of each species of fish at the month of March, April and May are homogeneous.

H1: The distribution of each species of fish at the month of March, April and May are not homogeneous.

Ho: The mean of the distribution of order - Perciformes - at Nhangattiri and Velliyamkallu are equal.

HI: The mean of the distribution of order - Perciformes - at Nhangattiri and Velliyamkallu are not equal.

Here the p- value 0.4832 and α = 0.05, so it is so clear that the mean of the distribution of order Perciformes at Nhangattiri and Velliyamkallu are equal. In the present study alpha diversity and beta diversity were calculated. Beta diversity was calculated using Jaccard's index.

Sj = C/(c+a+b)

Where 'c' is number of species common to both sites, 'a' is the number species unique to site A and 'b' is the number of species unique to site B.

In the present study,

c = 9, a = 8, b = 3

 $S_i = 9/(9+8+3) = 0.45$

Here the beta diversity index is 45 %.

Which means both sites shared some 45 % of species. In the present study alpha diversity values (Dominance, Shannon, Simpson, Evenness, Margalef and Fisher alpha) were calculated for Site 1 (Table 9, Fig. 3). The range of dominance was 0.09002 – 0.8595 and Simpson index values ranged from 0.7967 – 0.914, Shannon ranged from 2.128 – 2.64, Evenness ranged from 0.4939 – 0.8241, Margalef ranged from 2.611 – 2.727, Fisher alpha ranged from 0.8396-0.8965, Shannon ranged from 2.101-2.331, Evenness from 0.6815-0.8851, Margalef ranged from 1.1992-2.086 and Fisher alpha ranged from 2.628-2.805 (Table 10, Fig. 4). The range of dominance was 0.09002-0.8595 and Simpson index ranges from 0.7967-0.914, Shannon ranges from 2.128-2.64, Evenness ranges from 0.4939-0.8241, Margalef ranges from 2.611-2.727, Fisher alpha ranges from 3.476-3.727, in the case of Site I. While in the case of Site II, Dominance index ranges from 0.1035-0.1604, Simpson ranges from 0.8396-0.8965, Shannon ranges from 0.6815-0.8851, Margalef ranges from 1.1992-2.086 and Fisher alpha ranges from 2.628-2.805. The beta diversity using Jaccard's index shows that both the sites shared 45 % of species.





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CONCLUSIONS

The present study on the fish diversity in Bharathapuzha River during the period of December 2020 - May 2021 recorded a total of 20 species of fishes belonging to 8 orders. The species are Pseudetroplus maculatus, Oreochromis mossambicus, Channa striata, Channa marulius, Pseudosphromenus cupanus, Megalops cyprinoids, Garra mullya, Aplochielus lineatus, Mystus montanus, Devario malabaricus, Heteropneustes fossilis, Wallago attu, Pethia punctata, Dawkensia filamentosa, Anabas testudineus, Clarias garepinus and Garra stenorhynchus. The most abundant order was Perciformes. The most abundant family was Cyprinidae. Oreochromis mossambicus, recorded from the two study areas comes under vulnerable category. Pethia punctata is endemic to the study area. Oreochromis mossambicus and Clarias garepinus are the exotic fish species in the study area. It is noted that the distribution of each species of fish at the month of December, January and February are homogeneous. Also, the distribution of each species of fish at the month of March, April and May are homogeneous. The mean of the distribution of order -Perciformes - at Nhangattiri and Velliyamkallu are equal. Alpha diversity (Dominance, Shannon, Simpson, Evenness, Margalef and Fisher alpha) and Beta diversity indices were calculated. In site 1 Shannon index was highest in December (2.616), Margalef in May (2.727), Simpson in February (2.0910). While in Site II, Dominance index was high in April (0.1093), Shannon in December and January (2.363), Evenness and Margalef in May (2.016) and Fisher alpha also in May (2.815). The beta diversity using Jaccard's index shows that both the sites shared 45 % of species. The diversity values indicate moderately high species diversity in the study sites located in Bharathapuzha River.

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Table 1. Site-I-Nhagattiri (Numerical Abundance of Fish Species at Site-I-Month wise Data)

SL.NO	SPECIES	DEC	JAN	FEB	MAR	APR	MAY	TOTAL
1	Pseudetroplus maculatus	12	10	16	10	14	6	68
2	Channa striata	12	12	18	8	10	5	65
3	Channa marulius	9	12	10	11	8	5	55
4	Oreochromis mossambicus	33	30	29	28	20	10	150
5	Pseudosphromenus cupanus	28	28	29	30	26	9	150
6	Megalops cyprinoides	25	20	18	19	18	10	110
7	Garra mullya	33	33	36	38	32	12	184
8	Aplochielus lineatus	14	14	15	9	10	8	70
9	Mastacembelus armatus	22	22	23	13	15	8	103
10	Parambassis thomassi	8	8	9	3	8	5	41
11	Xenentoden cancila	37	37	41	45	38	32	230
12	Mystus montanus	9	12	18	11	14	10	74
13	Devario malabaricus	20	20	10	16	20	12	98
14	Heteropneustes fossilis	12	20	28	32	25	9	126
15	Wallago attu	12	12	18	8	16	8	74
16	Pethia punctata	80	82	80	80	80	67	469
17	Dawkensia filamentosa	40	55	60	98	85	137	475

Table 2. Site-II-Velliyamkallu (Numerical Abundance of Fish Species at Site-II-Month wise Data)

SL.NO	SPECIES	DEC	JAN	FEB	MAR	APR	MAY	TOTAL
1	Anabas testudineus	32	30	30	18	16	12	138
2	Clarias gariepinus	20	20	22	18	20	7	107
3	Garra stenorhynchus	19	16	12	13	10	5	75
4	Dawkensia filamentosa	15	12	10	9	10	32	88
5	Wallago attu	7	8	7	3	7	4	36
6	Xenentoden cancila	37	40	40	38	40	50	245
7	Pethia punctata	30	32	40	24	36	46	208
8	Pseudetroplus maculatus	10	10	9	13	10	8	60
9	Garra mullya	18	26	25	29	22	9	129
10	Oreochromis mossambicus	28	26	30	18	26	11	139
11	Channa marulius	9	12	10	11	10	7	59
12	Channa striata	10	10	15	15	15	6	71

Table 3. Summary: Site-I-Nhangattiri (Abundance of Fish Species at Site-I-December, January and February)

Groups	Count	Sum	Average	Variance
December	17	406	23.88235	321.3603
January	17	427	25.11765	361.6103





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February	17	458	26.94118	355.6838
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Table 4: ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	80.5098	2	40.2549	0.11627	0.890484	3.190727
Within Groups	16618.47	48	346.2181			
Total	16698.98	50				

Here the p- value = 0.8905 and α = 0.05, so it is so clear that the distribution of each species of fish at the month of December, January and February are homogeneous.

Table 5. Summary: Site-I-Nhangattiri (Abundance of Fish Species at Site-I-March, April and May)

Groups	Count	Sum	Average	Variance
Column 1	17	459	27	695.875
Column 2	17	439	25.82353	523.9044
Column 3	17	353	20.76471	1125.316

Table 6: ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	373.1765	2	186.5882	0.238696	0.788584	3.190727
Within Groups	37521.53	48	781.6985			
Total	37894.71	50				

Here the p- value = 0.7885 and α = 0.05, so it is so clear that the distribution of each species of fish at the month of March, April and May are homogeneous.

Table 7.Frequency distribution of Perciformes at Nhangattiri and Velliyamkallu,

Nhangattiri	DEC	JAN	FEB	MAR	APR	MAY
Channa striata	12	12	18	8	10	5
Channa marulius	9	12	10	11	8	5
Oreochromis mossambicus	33	30	29	28	20	10
Parambassis thomassi	8	8	9	3	8	5
Velliyamkallu	DEC	JAN	FEB	MAR	APR	MAY
Anabas testudineus	32	30	30	18	16	12
Anabas testudineus Pseudetroplus maculatus	32 10	30 10	30 9	18 13	16 10	12 8

Table 8. t-test

	Perciformes at Nhangattiri	Perciformes at Velliyamkallu
Mean	77.75	102
Variance	2416.917	1796.667





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Observations	4	4
Pooled Variance	2106.792	
Hypothesized Mean Difference	0	
df	6	
t Stat	-0.74716	
P(T<=t) two-tail	0.483206	
t Critical two-tail	2.446912	

Here the p- value 0.4832 and α = 0.05, so it is so clear that the mean of the distribution of order Perciformes at Nhangattiri and Velliyamkallu are equal.

Table 9. Biodiversity indices for Site I

DIVERSITY INDICES AT SITE 1										
DEC,2020 JAN 2021 FEB 2021 MAR, 2021 APR, 2021 MAY,2021										
TAXA_S	TAXA_S 17 17 17 17 17 17									
INDIVIDUAL	406	427	458	459	439	353				

	DEC 2020	JAN 2021	FEB 2021	MAR 2021	APR 2021	MAY 2021
DOMINANCE_D	0.09002	0.09056	0.8595	0.1117	0.1023	0.2033
SIMPSON_1-D	0.91	0.9094	0.914	0.8883	0.8977	0.7967
SHANN0N_H	2.616	2.615	2.64	2.466	2.548	2.128
EVENNESS_e^H/S	0.8045	0.8038	0.8241	0.6925	0.7518	0.4939
MARGALEF	2.664	2.642	2.611	2.611	2.63	2.727
FISHER_ALPHA	3.588	3.541	3.478	3.476	3.516	3.727

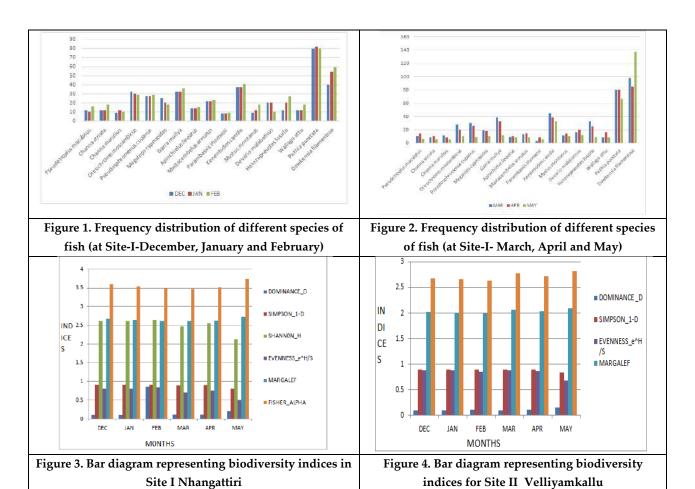
Table 10. Biodiversity indices for Site II Velliyamkallu

DIVERSITY INDICES AT SITE 2						
DEC 2020 JAN 2021 FEB 2021 MAR 2021 APR 2021 MAY 2021						
TAXA_S	12	12	12	12	12	12
INDIVIDUAL`	235	242	250	209	222	197

	DEC 2020	JAN 2021	FEB 2021	MAR 2021	APR 2021	MAY 2021
DOMINANCE _D	0.1035	0.1039	0.1089	0.1055	0.1093	0.1604
SIMPSON_1-D	0.8965	0.8961	0.8911	0.8945	0.8907	0.8396
SHANNON_H	2.363	2.363	2.331	2.352	2.34	2.101
EVENNESS_e^H/S	0.8848	0.8851	0.8576	0.8755	0.8652	0.6815
MARGALEF	2.015	2.004	1.992	2.059	2.036	2.086
FISHER_ALPHA	2.674	2.652	2.628	2.766	2.718	2.815



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RESEARCH ARTICLE

Molecular Mechanism of Herbal Root Canal Irrigants in Periapical **Tissue Healing in Pediatric Dental Patients**

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ABSTRACT

Irrigants helps in proper disinfection and removal of infected microbes and use of an efficient material as a irrigant can help in reducing the inflammation and healing of wounds thereby increasing the success rates in root canal procedure. [6] Sodium hypochlorite, Chlorhexidine, Citric acid, hydrogen peroxide, ethylenediaminotetraacetic acid and other irrigants are commonly used in endodontics. The advantages of using herbal alternatives include prolonged storage, easy availability, cost effectiveness, minimal cytoxicity, lack of microbial resistance so far. Therefore, the aim of the article is to list the molecular mechanism of wound healing for the herbal materials which could be used as an irrigant in root canal treatment.

Keywords: hypochlorite, Chlorhexidine, hydrogen peroxide, Sodium Citric acid, ethylenediaminotetraacetic acid and other irrigants are commonly used in endodontics





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INTRODUCTION

Oral disease continues to be a major health problem world-wide. Dental caries and periodontal problems are the most important oral health problems. The primary objective of performing pulpal therapy in primary teeth was to maintain the integrity and preserve the health of oral tissues.[1] Preserving a natural tooth in the dental arch helps to maintain the arch space and provides proper eruption of the underlying succedaneous tooth bud thereby maintaining the functional quality of life in children. Endodontic treatment in primary teeth was perceived to be highly tedious due to the complex anatomical diversification configured in its root canal system coupled with difficulty in paediatric behavioural management.[2] Despite efficient chemo mechanical preparation and thorough copious irrigation of the root canals, there are still chances of failure in pulp therapy due to entrapped microbes in the fins and isthmus of the tortuous, narrow and ribbon shaped root canals of primary teeth.[3] As a result, materials with advanced and additional antimicrobial properties have emerged to provide root canals free of microorganisms due to perceived challenges in complete debridement of the canal system related to the intricate structure and closer location to the succedaneous tooth bud. The success of pulpectomy treatment depends on the method and the quality of instrumentation, irrigation, disinfection and obturation of the root canals. Due to the rising incidence of unforeseen harmful reactions to cytotoxic reactions and the limited effectiveness of existing commercial treatments in thoroughly removing microorganisms from deep dentin tubules, researchers are compelled to investigate alternative solutions.[4] Natural herbal medicaments have an imperative role in today's medicine, due to increased antibioticresistant strains and side effects produced by commercially available synthetic medicaments. In the present era, there has been an immense popularity of using herbal or natural products in various fields of science due to their high antimicrobial activity, biocompatibility, anti-inflammatory and anti-oxidant properties.[5] Irrigants helps in proper disinfection and removal of infected microbes and use of an efficient material as a irrigant can help in reducing the inflammation and healing of wounds thereby increasing the success rates in root canal procedure.[6]Sodium hypochlorite, Chlorhexidine, Citric acid, hydrogen peroxide, ethylenediaminotetraacetic acid and other irrigants are commonly used in endodontics. The advantages of using herbal alternatives include prolonged storage, easy availability, cost effectiveness, minimal cytoxicity, lack of microbial resistance so far. Therefore, the aim of the article is to list the molecular mechanism of wound healing for the herbal materials which could be used as an irrigant in root canal treatment.

METHODOLOGY

Procedure

Using the PRISMA(Preferred Reporting Items for Systematic Reviews and Meta Analyses) guidelines, this systematic review was conducted. The studies were chosen after reviewing the abstracts and the texts according to the inclusion and exclusion criteria. None of the manuscript authors was contacted during the process.

Research Question

- Whether using herbal material as irrigant, is effective to eradicate root canal infection and promote the success rate of endodontic procedure?
- Is there any difference in the antimicrobial efficacy of herbal materials versus conventional materials?

The focused question was developed by PICO framework which includes:

- Patient/Population-The study characteristics include country, year of publishing. Participant characteristics include condition of teeth before treatment.
- **Intervention** -Pulpectomy procedure, root canal treatment in young permanent teeth, type of irrigating solutions used, antimicrobial efficacy in invitro study.
- Comparison- herbal materials compared to convention materials when used as irrigant.
- Outcome of Interest- Clinical and radiographic success rates were determined and the antimicrobial efficacy was
 evaluated.





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Search strategy

Data were collected from electronic databases (PubMed, Web of Science and Scopus) to identify studies published in English without restriction on the year of publication. The keywords used were 'herbal materials in endodontics', 'herbal irrigant', candidaalbicans, 'E.faecalis'. The search details were herbal materials (all fields) AND(efficacy against candida albicans and E.fecalis in root canal infection).

Criteria for Inclusion and Exclusion criteria

The inclusion criteria included were all studies published in english without any restrictions on the year of publishing and studies which evaluated the antimicrobial efficacy of herbal materials against E.fecalis ,Candida albicans in root canal infection. The types of studies were *invitro* and *invivo* studies, prospective and retrospective studies were included. Studies related to use of herbal materials in endodontic practice when used as irrigant, were included in this review. Studies which included the The search also encompassed the use of herbal materials either alone or in combination with conventional materials. Exclusion criteria were those studies that resulted in cytotoxicity of irrigants in *invivo* studies were excluded. The use of herbal materials other than in use in endodontics (such as irrigants) were excluded from the search.

Synthesis of evidence

A total of 15 articles were included based on the inclusion and exclusion criteria as presented in table 1.Studies from the year 2006 till 2022 were included in the study. The results showed the antimicrobial efficacy of herbal irrigants and the efficacy of using herbal materials as irrigants in root canal procedures.

DISCUSSIONS

The primary goal of endodontic treatment is to thoroughly clean and shape the root canal using manual and rotary instruments while continuously irrigating the area. Instrumentation, irrigation with chemicals, and application of medication to the root canal system are conducted between treatment sessions to achieve this purpose.[22] The oral cavity microbes are typically opportunistic pathogens. They can invade and initiate an infectious process within the root canal. Prolonged root canal infections lead to an increased presence of facultative anaerobes. One of the most prevalent microorganisms that may be grown from unsuccessful root canals that undergo retreatment is E. faecalis. The presence of biofilm around the bacteria ,makes them resistant to phagocytosis, antibodies and antimicrobial agents. This is attributed to the protective barrier provided by the extracellular matrix. The capacity of the microorganisms to withstand chemo-mechanical preparation is due to the participation of biofilms in horizontal gene transfer, which spreads antibiotic resistance genes across many therapeutically relevant species. Therefore, optimal intracanal irrigants are those that exhibit strong antimicrobial properties, thereby improving the effectiveness of instrumentation procedures. [23] Sodium hypochlorite (NaOCl) has been been the most widely used root canal irrigating solution for over decades. Due to its capabilities of tissue dissolving and antibacterial activity, it is the preferred irrigating solution for the treatment of teeth with pulp necrosis. Unfavourabletraits such as tissue toxicity, potential of emphysema from overfilling, allergic potential, unpleasant taste and odour, and incomplete cleansing of root canal walls are concerns.[24] Chlorhexidine is the most potent chemotherapeutic agent against many microbes.

It is a broad spectrum antimicrobial agent, effective against both gram positive and gram-negative microorganisms. At low concentration, it is bacteriostatic and at high concentration bactericidal. Chlorhexidine side effects include tooth staining, changes in taste perception, and the potential for developing resistance against microbes. [25] With the increasing popularity of traditional and holistic/alternative medicines due to their natural origin, easy availability, efficacy, safety and fewer side effects ,herbal plant extracts have been used as irrigating solutions in cleaning the canal system. Numerous studies have demonstrated that herbal plant extracts effectively eradicate microbes responsible for dental diseases, establishing their efficacy as antimicrobial agents. [26] A successful endodontic procedure involves not only cleaning the debris present in the can albut also to promote wound healing of the periodontal and interradicular areas. Wound healing involves a complex physiological process that includes stages of





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hemostasis, inflammation, proliferation, and tissue remodeling.[27]Plants have been extensively studied for their capacity to augment innate repair mechanisms. With recent advancements in science, the focus has drifted from using the whole plant to studying the active constituents present in them. Among the herbal materials, curcumin is the most effective in wound healing. Curcumin is a low-molecular-weight polyphenol found in the rhizomes of Curcuma longa and Curcuma aromatica[28]The primary bioactive component of turmeric rhizomes is Curcumin (77Curcumin constitutes the majority (77%) of the active compounds in turmeric rhizomes, demethoxycurcumin (17%), bisdemethoxycurcumin (3%), and cyclocurcumin (3%). Curcumin contributes to multiple phases of wound healing, such as inflammation, maturation, and proliferation, thereby promoting and accelerating the healing process. However, its therapeutic effectiveness is limited byfactors such as limited absorption into the body, insolubility in water, and quick breakdown in metabolism.[29]Curcuminis an indeginous existing occurring polyphenolic antioxidant which has a potential in wound healing. The primary goal of wound healing is to repair tissue integrity and uphold balance within the body. It accelerates wound contraction and enhances the healing capacity of wounds. It is lipophilic in nature, and it gains transmembrane permeability.

It can be integrated into aqueous solvents using lipids, surfactants, albumins, and biopolymers. Recent research on nanoformulations loaded with curcumin for wound treatment has demonstrated the cellular processes of curcumin in the recovery process and its impact on inflammation. This technology could be incorporated to enhance the use of curcumin as an irrigant in periapical tissue healing.[30] Laboratory studies and research on living organisms have demonstrated that Aloe vera can inhibit thromboxane, which impedes wound healing, while also promoting the healing cascade and reducing inflammation. Additionally, the presence of magnesium lactate in the gel can prevent histamine production, thereby preventing irritation and inflammation. Aloe vera also boosts the immune system and stimulates the production of cytokines. It effectively reduces inflammatory responses by inhibiting IL-6 and IL-8, decreasing leukocyte adhesion, increasing IL-10 levels, and lowering TNF alpha levels.[31] Its ability to regenerate tissue is attributed to glucomannan, a compound abundant in polysaccharides like mannose. Glucomannan engages with fibroblast growth factor receptors, boosting their function and promoting their proliferation. This process not only increases collagen production but also alters collagen composition and promotes collagen cross-linking, thereby facilitating wound healing.[32] Triphala possess a number of medicinal properties like anti-inflammatory, antibacterial, anti-fungal, antiviral, anti-malarial, anti-mutagenic, radioprotective, anti-allergic, anti-cancer, cardiotonic, hypocholesterolaemic, capillary strengthening, hepatoprotective, immunomodulatory, adaptogenic, analgesic and anti-oxidant activity.[10]

CONCLUSIONS

India known for its diversity and its knowledge of traditional medicine, has been practicing the use of herbal plant products in preventing and curing diseases over the centuries. Plants and natural sources are fundamental to contemporary medicine and significantly contribute to the production of commercial pharmaceuticals today. About 25% of medicaments prescribed worldwide are derived from plants. Herbal products utilized in endodontics offer numerous benefits over the conventional materials in terms of safety, ease of use, cost effective, increased storability, lack of microbial tolerance. Comprehensive knowledge of the molecular mechanisms of herbal materials can accelerate healing potential and enhance the success rates of endodontic procedures. Research indicates promising effectiveness when herbal medicaments are utilized either independently or in combination with conventional materials in endodontic treatments. As the herbal materials are intended to be used in human ,they must undergo comprehensive in vitro and invivo testing before use. Many invitro studies have proved the efficacy of herbal materials ,but biocompatibility and safety must be evaluated in clinical research. Herbs are harmless when used appropriately and can be hazardous if incorrectly used. To facilitate this, proper guide with scientific evidence of the benefits and instructions of use and side effects if any should be provided before the marketing of the herbal medicament.





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Table 1: Characteristic Table showing Antimicrobial Efficacy of Different Root Canal Irrigants

Study	Aim	Observation/Result	Inference	Reference
Lahijani MS et al 2006	Compare the efficacy of chamomile hydroalcoholic extract and tea tree oil to a 2.5% sodium hypochlorite (NaOCl) solution in cleaning as an intracanal irrigant for eliminating the smear layer.	The results indicated that the most effective smear layer removal was achieved using NaOCl followed by a final rinse with 17% EDTA (negative control), with chamomile extract being the next most effective.	Chamomile's efficacy in removing the smear layer exhibited greater efficacy to that of NaOCI alone but inferior to the combination of	[7]





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		Chamomile extract proved to be substantially more efficient than both distilled water and tea tree oil $(P < 0.008)$.	NaOCl and EDTA.	
Murray P et al 2008	Compare the in vitro efficiency of Morinda citrifolia juice (MCJ) with sodium hypochlorite (NaOCl) and chlorhexidine gluconate (CHX) in eliminating the smear layer from the canal walls of endodontically treated teeth	The study concluded that efficiency of MJC was similar to NaOCl in combination with EDTA as an intracanal irrigant.	MJC seems to be the juice identified as a potential alternative to NaOCl for use as an irrigant.	[8]
Prabhakar J et al2010	Assess the antimicrobial effectiveness of Triphala, green tea polyphenols (GTP), MTAD, and 5% sodium hypochlorite against E. faecalis biofilm formed on tooth substrate	The results indicated that the 3-week biofilm experienced total suppression of bacterial proliferation with Triphala, MTAD, and NaOCl. In contrast, GTP and saline showed the existence of bacterial proliferation.	Triphala, green tea polyphenols, and MTAD was highly effective against bacterial activity. Given the numerous undesirable properties of NaOCl, using herbal alternatives as root canal irrigants could be beneficial.	[9]
Bohora A et al 2010	compare the antimicrobial effect of neem leaf extract and 2% hypochlorite against E. faecalis, C. albicans and mixed culture.	The results showed that neem leaf extract was effective against E. faecalis and C. albicans and mixed state.	The microbial inhibition potential of neem leaf extract observed in this study suggests its potential use as an intracanal medication.	[10]
Vinothkumar TS et al 2013	evaluate the antimicrobial efficacy of various herbal extracts namely Curcuma longa (CL), Azadiracta indica (AI), Aloe barbadensis (AV), Myristica fragrans (MF) and Terminalia chebula (TC) as endodontic irrigant against Enterococcus faecalis and Candida albicans using real- time quantitative polymerase chain reaction (qPCR).	The result showed that Neem was highly effective to 5.25% NaOCl in reducing Enterococcus faecalis and Candida albicans.	The study concluded that Neem leaf extract was effective against E.faecalis and Candida albicans when compared to 5.25 % sodium hypochlorite.	[11]
Eswar K et al 2013	compared the effectiveness of garlic extract with 2%	The specimens were analyzed using real-time PCR. 2% CHX	Herbal medicaments like	[12]





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	chlorhexidine (CHX) and calcium hydroxide (Ca(OH) ₂) in decontaminating dentinal tubules contaminated with Enterococcus faecalis by using real-time polymerase chain reaction (PCR).	showed better antibacterial efficacy against E. faecalis by using real- time PCR. Garlic extract showed better antibacterial efficacy compared to Ca(OH)2 against E. faecalis.	garlic could be used as irrigant in root canal treatment.	
Raghavendra et al 2014	assess the antimicrobial effectiveness of neem extract, 3% sodium hypochlorite, and 2% chlorhexidine against Candida albicans.	A statistically significant disparity was observed in the zones of inhibition between 3% NaOCl and Neem extract compared to 2% CHX.	The study concluded that efficacy of Neem extract is comparable to 3% NaOCl against C. albicans and it is significantly better than 2% CHX.	[13]
Jerin J et al 2015	Assess the antimicrobial effectiveness of Green Tea extract, Garlic extract, Neem leaf extract, and Sodium hypochlorite as agents for root canal irrigation against E. faecalis and C. albicans.	The zone of inhibition was recorded. 2.5 % sodium hypochlorite showed maximum inhibitory effect against Enterococcus faecalis followed by green tea, garlic and neem. Against Against Candida albicans, 2.5% sodium hypochlorite showed the greatest inhibitory effect, followed by garlic extract, green tea extract, and neem leaf extract.	The study concluded that Herbal extracts showed significant inhibitory effects against Enterococcus faecalis and Candida albicans when compared with 2.5% sodium hypochlorite.	[14]
Gupta A et al 2015	evaluate the effectiveness of three plant extracts when used as irrigant in removal of smear layer.	the herbal extracts of Syzygium aromaticum (S. Aromaticum), Ocimum sanctum (O. Sanctum) and Cinnamomum zeylanicum (C. zeylanicum) plant extracts was assessedfor their effectiveness in removing the smear layer and showed greater efficacy in cleaning root canal walls when used in conjunction with EDTA.	study concluded that herbal plant extracts were not effective in eliminating smear layerwhen used alone.But in adjunct was effective .	[15]
Jose et al 2016	Compared the antimicrobial efficacy of various irrigants, including QMiX, guava leaf extract, aloe vera extract, 2.5%	The results showed that QMiX exhibited the greatest inhibitory effect against Enterococcus faecalis and	QMiX showed the most favorable outcomes among the evaluated	[16]





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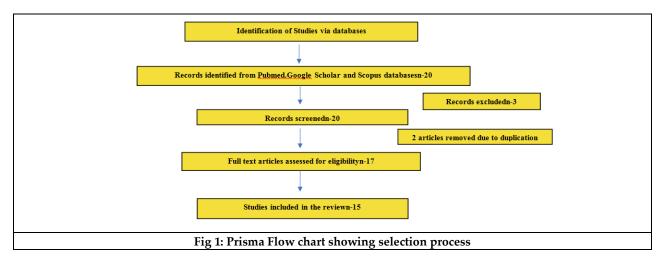
	sodium hypochlorite, and 2% chlorhexidine gluconate, against Enterococcus faecalis and Candida albicans.	Candida albicans, followed by 2% chlorhexidine, 2.5% sodium hypochlorite, guava leaf extract, and aloe vera extract. The study concluded that Guava leaf extract showed greaterinhibitory effects against Enterococcus faecalis and Candida albicans.	solutions and can be regarded as a promising alternative to current root canal irrigants.	
Divya S et al 2016	ex-vivo study was done to evaluate the efficacy of 40% honey, 100% neem leaf extract and 5.25% sodium hypochlorite as an intracanal irrigant against the isolated microorganisms from infected root canal.	The results showed that 5.25% sodium hypochlorite is a more effective root canal irrigant compared to neem leaf extract and honey.	It was also noted that 100% neem leaf extract exhibits a stronger antimicrobial effect compared to 40% honey.	[17]
Babaji P et al 2016	evaluated the impact of herbal root canal irrigants (Morinda citrifolia, Azadirachta indica extract, Aloe vera) in comparison to sodium hypochlorite (NaOCl).Antibacterial inhibition was assessed using agar well diffusion method.	The largest zone of inhibition against E. faecalis waswas observed with NaOCl, followed by extracts from M. citrifolia and A. indica, and the least inhibition was noted with A. vera extract	M.citrifolia , A.indica extract ,Aloe vera extract could be used as herbal irrigant	[18]
Chandwani M et al 2017	the study was to determine the microbial reduction in deciduous molars using Morinda citrifolia juice (MCJ) as irrigating solution.	The results showed that the both the irrigants, 1% NaOCl and MCJ, were useful in the reduction of mean CFUs/ml postoperatively.	The study concluded that the antimicrobial effectiveness of MCJ in the root canals of deciduous teeth. As there was decreased toxicity and antibacterial effect of MCJ, it could be used as a root canal irrigant in endodontic therapy of primary teeth.	[19]
Choudhary E et al 2018	Study was done to evaluate the e efficacy of commercial preparations of Morinda citrifolia juice (MCJ) and Triphala juice contrary to Enterococcus faecalis and Candida albicans.	The results showed a There was a notable reduction in microbial counts for both microbes across all groups at S1, with only CHX showing additional reduction in microbial counts for both microorganisms at S2	The study concluded that the antimicrobial potential of various irrigants were higher for CHX, while MCJ and Triphala juice	[20]





Sourabh Ramesh Joshi et al.,

			showed substantial reductions. These medicaments can be used effectively as root canal irrigant.	
Sotomil JM et al 2019	The study was done to assess the antimicrobial characteristics and potential application of curcumin as an irrigating solution	There was a decrease in values of viable bacteria in curcumin-based irrigants, which was higher than the TAP-treated group.	The conclusion of the study was Curcumin appears to serve as an alternative to TAP in managing infection.	[21]







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RESEARCH ARTICLE

Effect of Pilates Exercises, Yogic Practices and Combined Pilates Exercises and Yogic Practices on Selected Physiological Variables among **College Female Students**

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ABSTRACT

The present study was designed to find out the effect of Pilates exercises, yogic practices and combined Pilates exercises and yogic practices on selected physiological variables among college female students. For this purpose sixty (N=60) B Ed college female students studying various affiliated colleges to Tamil Nadu Teachers Education University, Chennai, Tamil Nadu India were selected randomly as subjects. The age of the subjects were ranged between 18-21 years. The subjects were assigned at random into four groups of fifteen each (n=15) namely, Pilates exercises, yogic practices, combined Pilates exercises and yogic practices and control group. Group-I underwent Pilates Exercises, Group-II underwent yogic practices, Group-III underwent combined Pilates exercises and yogic practices and Group-IV acted as control. The duration of the training period for all the three experimental groups was restricted to twelve weeks and the number of sessions per week was confined to three in a week. For combined Pilates exercises and yogic practices the training period was restricted to alternative weeks for twelve weeks. Among various physiological variables Resting pulse rate and Respiratory rate were selected as dependent variable. Resting pulse rate was measured through pulse monitor and Respiratory Rate was measured through standard pulse oximeter. All the subjects were tested prior to and immediately after the training for the entire selected variable. The data obtained from the experimental groups before and after the experimental period were statistically analyzed with Analysis of covariance (ANCOVA).





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Whenever the 'F' ratio for adjusted post test means was found to be significant, the Scheffe's Post hoc test was applied to determine the paired mean differences. The level of confidence was fixed at 0.05 level for all the cases. The results of the study showed that there was a significant difference among all the groups. Further the results of the study showed that combined Pilate's exercises and yogic practices group was found to be better than the Pilate's exercises group and yogic practices group in Resting Pulse Rate and Respiratory Rate.

Keywords: Pilates Exercises, Yogic Practices, Combined Pilates Exercises and Yogic Practices, Resting Pulse Rate, Respiratory Rate.

INTRODUCTION

Joseph Pilates, a guy of German descent, is credited with creating Pilates in the early 1900s. At the conclusion of World War 1, a hospital on the Isle of Man, which is sandwiched between the United Kingdom and Ireland, started using Pilates to help patients who had mobility issues. Pilates exercises were performed while supporting the lower extremities of the body with a shock-absorbing device, and this technique became well-known as a way to speed up a patient's rehabilitation [1]. At first, Pilates was a way of promoting motion during the early stages of rehabilitation by giving help or assistance as needed.8 Pilates developed more as a special method that combined physical and psychological aspects through many experiences. For years, Pilates has been used primarily by people who've had back or neck injuries. [2]. Although Pilates has been used as an exercise related to dance, demand has been rising to use Pilates as a method of physical treatment [3]. Pilates is more than just a set of randomly selected motions; Pilates training is more than just exercise. Pilates is a method of physical and mental conditioning that can help people become stronger, more flexible, and more coordinated as well as reduce stress, sharpen their minds, and feel better overall. Anyone and everyone can benefit from Pilates. Pilates is a form of exercise that has Germanic undertones and is founded on the same principles as yoga. Its primary goal is to increase the strength and flexibility of the hips, lower back, and abdomen. This exercise was created by the late Joseph Pilates in the 1920s as a way to treat chronic illnesses including asthma. Its basic concept calls for preserving spine stabilization while increasing muscle strength, stamina, and flexibility. Pilates is an extremely efficient kind of exercise that incorporates yoga (a mind-body technique), breath, flexibility, relaxation, strength, and endurance. [4]. Yoga is the study, the way, the means, and the ultimate goal, and its fundamental ideas include the fusion of opposites, the impact of the outside world on the body, the desire for and search for liberation in various forms, the union of one's individual consciousness with the Universal consciousness, and the pursuit of realizing and achieving one's true self. Yoga has demonstrated over the course of its long history that it symbolizes the effort we will put forth in achieving something, the path that will lead us to the ultimate achievement, the progress we will make along the way, and, in the end, the end result: the sum of all of our achievements. [5]. Regular practice of yoga helps to reduce incidence & control diabetes, hypertension, and various other disorders. Yoga helps to treat hypertension as it relaxes body and breathing exercise tends to act on control system of cardio-vascular functions [6]. The respiratory rate is a basic vital sign that can be affected by a variety of pathological disorders, such as pneumonia, unfavorable cardiac events, and clinical deterioration, as well as stresses including emotional stress, cognitive load, heat, cold, physical effort, and exhaustion from exercise. The sensitivity of respiratory rate to these conditions is greater than that of the majority of other vital signs, and the availability of numerous effective technology options for detecting respiratory rate has significant consequences for healthcare, workplace environments, and sport[7]. At the conclusion of the eighth week of the Pilates, walking and combined walking and Pilates, the resting systolic blood pressure fell. After walking and combining Pilates and walking exercise, resting diastolic blood pressure also decreased [8].





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METHODOLOGY

The study was conducted on sixty (N=60) B.Ed college female students studying various affiliated colleges to Tamil Nadu Teachers Education University, Chennai, Tamil Nadu India were selected randomly as subjects. The age of the subjects were ranged between 18-21 years. The subjects were assigned at random into four groups of fifteen each (n=15) namely, Pilates exercises, yogic practices, combined Pilates exercises and yogic practices and control group. Group-I underwent Pilates Exercises, Group-II underwent yogic practices, Group-III underwent combined Pilates exercises and yogic practices and Group-IV acted as control. 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 duration was limited to alternate weeks for a total of twelve weeks for combined Pilates and yoga workouts. The dependent variables were chosen from a variety of physiological variables and included the resting pulse rate and respiratory rate. A conventional pulse oximeter was used to measure the respiratory rate and the resting pulse rate, respectively [9] [10]. ANCOVA was used to statistically assess the data collected from the experimental groups prior to and following the experimental period. 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 significant. For each scenario, the degree of confidence was set at 0.05.

RESULTS AND DISCUSSIONS

Table -1 shows the findings of the analysis of covariance on specific physiological variables based on the pre, post, and adjusted test scores for the Pilate's exercises group, the Yoga group, the combined Pilate's exercises and Yoga group, and the Control group.

Resting Pulse Rate

According to Table 1, the pre-test mean resting pulse rate for the Pilates Exercises group, the Yogic Practices group, the Combined Pilates Exercises and Yogic Practices group, and the Control group, respectively, was 74.40, 74.73, 74.56, and 74.00. The corrected post test mean's calculated F-ratio of 1.91 is lower than the table value of 2.76 for df 3 and 56 necessary for significant at the 0.05 level of confidence. For the Pilates Exercises group, Yogic Practices group, Combined Pilates Exercises and Yogic Practices group, and Control group, the post test mean value of Resting Pulse Rate is 72.13, 72.00, 72.00, and 74.27, respectively. The obtained F-ratio of 31.85 for the adjusted post test mean is less than the table value of 2.76 for df 3 and 56 required for significance at 0.05 level of confidence. As further evidenced by Table 1, the adjusted post test mean value of Resting Pulse Rate for the Pilates Exercises group, the Yogic Practices group, the Combined Pilates Exercises and Yogic Practices group, and the Control group, respectively, is 72.14, 71.82, 71.93, and 74.51. The adjusted post test mean computed F-ratio of 65.73 is greater than the table value of 2.78 for df 3 and 55 necessary for significance at 0.05 level of confidence. The study's findings show that the corrected post test means of the experimental groups varied significantly on the rise in resting pulse rate. Scheffe's test was used as a post hoc test to evaluate which of the paired means had a significant difference, and the findings are shown in Table 2. The adjusted post test mean differences on resting pulse rate between the Pilates Exercises group and the Control group, the Yogic Practices group and the Control group, and the combined Pilates Exercises and Yogic Practices group and Control group are shown in Table 2 as 2.36, 2.69, and 2.57, respectively. These differences are greater than the confidence interval value of 0.62 and demonstrate significant differences at the 0.05 level of confidence. Table 2 also demonstrates that the adjusted post test means for the differences in Resting Pulse Rate between the Pilates Exercises group and the Yogic Practices group, the Pilates Exercises group and the Combined Pilates Exercises and Yogic Practices group, and the Yogic Practices group and the Combined Pilates Exercises and Yogic Practices group are 0.32, 0.21, and 0.11, respectively, which are less than the confidence interval value of 0.62, which shows there is no significant differences at 0.05 level of confidence. The study's findings showed that the adjusted post test averages of the Pilates Exercises group and the Control group, the Yogic Practices group and the Control group, and the combined Pilates Exercises and Yogic Practices group and the Control group all differed significantly in terms of resting pulse rate. Further, the study's findings showed that there was no statistically significant difference in Resting





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Pulse Rate between the groups that participated in Pilate's exercises and yogic practices, Pilates exercises and combined yogic and Pilates practices, and yogic practices group and combined yogic and Pilates exercises. However, compared to other groups, the Combined Pilates Exercises and Yogic Practices group significantly increased resting pulse rate. It may be concluded that the Combined Pilates Exercises and Yogic Practices group has exhibited better than the other experimental groups in decreasing Resting Pulse Rate. The mean value of experimental groups on Resting Pulse Rate is graphically represented in the Figure -1.

Respiratory Rate

According to Table 3, the pre-test mean value for the Pilates Exercises group, the Yogic Practices group, the Combined Pilates Exercises and Yogic Practices group, and the Control group, respectively, is 19.87, 19.93, 19.40, and 18.87. The corrected post test mean's calculated F-ratio of 1.35 is lower than the table value of 2.76 for df 3 and 56 necessary for significant at the 0.05 level of confidence. For the Pilates Exercises group, the Yogic Practices group, the Combined Pilates Exercises and Yogic Practices group, and the Control group, the post-test mean value of Respiratory Rate is 17.27, 17.27, 16.33, and 19.00, respectively. The obtained F-ratio of 6.97 for the adjusted post test mean is less than the table value of 2.76 for df 3 and 56 required for significance at 0.05 level of confidence. Table 1 further demonstrates that the corrected post test mean value of Respiratory Rate for the Pilates Exercises group, Yogic Practices group, Combined Pilates Exercises and Yogic Practices group, and Control group, respectively, is 17.04, 17.00, 16.41, and 19.41. The calculated F-ratio for the modified post test mean is 16.04, which is higher than the 2.78 table value for df 3 and 55 necessary for significance at the 0.05 level of confidence. According to the study's findings, there are substantial variations between the experimental groups' adjusted post-test means for the rise in respiratory rate. Scheffe's test was used as a post hoc test to evaluate which of the paired means had a significant difference, and the findings are shown in Table 4. According to Table 4, there are significant differences at the 0.05 level of confidence between the Pilates Exercises group and the Control group, the Yogic Practices group and the Control group, and the combined Pilates Exercises and Yogic Practices group and the Control group on the basis of adjusted post test means differences on Respiratory Rate. These differences are 2.37, 2.41, and 3.01, respectively, and are greater than the confidence interval value of 1.33. Table 2 also demonstrates that there were no significant differences in the adjusted post test means of Respiratory Rate between the Pilates Exercises group and the Yogic Practices group, the Pilates Exercises group and the combined Pilates Exercises and Yogic Practices group, and the Yogic Practices group and the combined Pilates Exercises and Yogic Practices group. According to the study's findings, there is a significant difference in respiratory rate between the adjusted post-test averages of the groups that participated in Pilates exercises, yoga practices, and combined Pilates exercises and yoga practices and the control group. The study's findings also showed that there was no statistically significant difference in respiratory rate between the groups that participated in Pilates exercises and yogic practices, in Pilates exercises and combined yogic and Pilates practices, in Yogic practices group and in combined yogic and Pilates practices group. However, the increase in Respiratory Rate was significantly higher for Combined Pilates Exercises and Yogic Practices group than other Experimental groups. It may be concluded that the Combined Pilates Exercises and Yogic Practices group has exhibited better than the other experimental groups in decreasing Respiratory Rate. The mean value of experimental groups on Respiratory Rate is graphically represented in the Figure -2.

CONCLUSIONS

The data analysis led to the following findings being made. In the selected criterion variable, such as Resting Pulse Rate and Respiratory Rate, significant differences in achievement were discovered between the Pilates Exercises group, Yogic Practices group, Combined Pilates Exercises and Yogic Practices group, and Control group. The resting pulse rate and respiratory rate considerably increased in the experimental groups, which included the Pilates exercises group, the yogic practices group, and the combined Pilates exercises and yogic practices group. In terms of improving Resting Pulse Rate and Respiratory Rate, the combined Pilate's exercises and yogic practices group performed better than the Pilates exercises group, the yogic practices group, and the Control group.





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Table 1: Values of Analysis of Covariance for Experimental Groups and Control Group on Resting Pulse Rate

		Adjusted Po	ost test Means	-		-			
Certain Variables	Pilates Exercises Group	Yogic Practices Group	Combined Pilates Exercises and Yogic Practices Group	Control Group	Source of Variance	Sum of Squares	df	Mean Squares	'F' Ratio
Pre Test	74.40	74.73	74.53	74.00	Between With in	4.32 0.75	3 56	1.44 0.75	1.91
Post Test	72.13	72.00	72.00	74.27	Between With in	55.73 32.67	3 56	18.58 0.58	31.85*
Adjusted Post Test	72.14	71.82	71.93	74.51	Between With in	67.44 18.81	3 55	22.48 0.34	65.73*

^{*} 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





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Table 2: The Scheffe's test for the differences between the adjusted post tests paired means on Resting Pulse Rate

		Adjusted				
Certain Variables	Pilates Exercises Group	Yogic Practices Group	Combined Pilates Exercises and Yogic Practices Group	Control Group	Mean Difference	Confidence Interval
	72.14	71.82			0.32	0.62
	72.14		71.93		0.21	0.62
Resting	72.14			74.51	2.36*	0.62
Pulse Rate		71.82	71.93		0.11	0.62
		71.82		74.51	2.69*	0.62
	_		71.93	74.51	2.57*	0.62

^{*} Significant at.05 level of confidence

Table 3: Values of Analysis of Covariance for Experimental Groups and Control Group on Respiratory Rate

		Adjusted Po	ost test Means	•				· ·	
Certain Variables	Pilates Exercises Group	Yogic Practices Group	Combined Pilates Exercises and Yogic Practices Group	Control Group	Source of Variance	Sum of Squares	df	Mean Squares	'F' Ratio
Pre Test	19.87	19.93	19.40	18.87	Between With in	10.98 152.00	3 56	3.66 2.71	1.35*
Post Test	17.27	17.27	16.33	19.00	Between With in	55.73 149.20	3 56	18.58 2.66	6.97*
Adjusted Post Test	17.04	17.00	16.41	19.41	Between With in	76.59 87.55	3 55	25.53 1.59	16.04*

^{*} 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

Table 4: The Scheffe's test for the differences between the adjusted post tests paired means on Respiratory Rate

			d Post test Means	, , , , , , , , , , , , , , , , , , ,		,	
Certain Variables	Pilates Exercises Group	Yogic Practices Group	Combined Pilates Exercises and Yogic Practices Group	Control Group	Mean Difference	Confidence Interval	
	17.04	17.00			0.04	1.33	
	17.04		16.41		0.64	1.33	
	17.04			19.41	2.37*	1.33	





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Respiratory	17.00	16.41		0.59	1.33
Rate	17.00		19.41	2.41*	1.33
		16.41	19.41	3.01*	1.33

^{*} Significant at.05 level of confidence

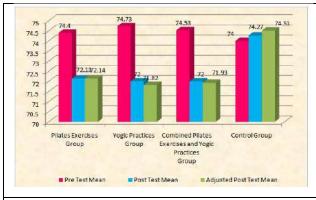


Fig-1: Bar diagram on ordered means of Resting Pulse Rate

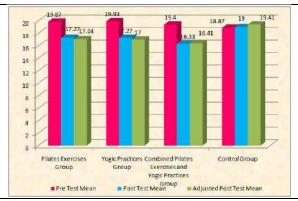


Fig-2: Bar diagram on ordered means of Respiratory Rate





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RESEARCH ARTICLE

Effect of Mindfulness Meditation on Psychological Well-Being of Students Enrolled in NIT Srinagar Garhwal, Uttarakhand

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ABSTRACT

This research examines the impact of mindfulness meditation on the psychological well-being of 120 undergraduate students at NIT Srinagar Garhwal, Uttarakhand. Mindfulness meditation, known for promoting psychological well-being and reducing stress, has gained popularity but hasn't been extensively studied among this specific student demographic. Participants were randomly assigned to an experimental group (n=60) receiving an 8-week mindfulness meditation program and a control group (n=60). Pre- and post-intervention assessments were conducted, and ANCOVA results revealed a significant difference in post-intervention psychological well-being between the groups (F (2, 117) = 22.962, p < 0.001). The experimental group showed a substantial increase in psychological well-being (Mean_Pre = 164.73, Mean_Post = 176.80), while the control group's scores remained relatively stable (Mean_Pre = 163.48, Mean_Post = 163.70). These findings support the hypothesis that mindfulness meditation positively affects well-being, aligning with previous research on its benefits. The implications suggest that educational institutions like NIT Srinagar Garhwal could consider integrating mindfulness programs into their curriculum to enhance students' mental health and well-being. However, this study has limitations, including a relatively short intervention period and a specific sample, necessitating future research to explore long-term effects and broader applications of mindfulness in academic settings. In conclusion, this research adds to the growing body of evidence indicating that mindfulness meditation is a promising approach to boost students' psychological well-being, offering potential benefits for individual growth and educational institutions.

Keywords: Mindfulness Meditation, Psychological Well-being, NIT Srinagar Garhwal, Students, **Experimental Study**





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INTRODUCTION

Mindfulness meditation, a practice rooted in ancient contemplative practice, has gained increasing recognition due to its potential to improve psychological well-being. In simple terms "the awareness that arises through paying attention on purpose in the present moment, non-judgmentally" (Kabat-Zinn, 2003, p. 145). The mindfulness meditation techniques have gained significant popularity in contemporary settings because of their efficacy in alleviating stress and enhancing overall psychological health. The practice has garnered growing popularity, as evidenced by the proliferation of mindfulness-based programs and interventions in various settings (Keng et al., 2011). Students pursuing higher education, such as those enrolled in institutions like the National Institute of Technology (NIT) Srinagar Garhwal, Uttarakhand, often encounter substantial stressors that can significantly impact their psychological well-being. Academic pressures, competitive environments, and the challenges of adjusting to new life situations can contribute to heightened stress levels, anxiety, and other mental health issues (Dyrbye et al., 2014; Beiter et al., 2015). Furthermore, the specific demands of engineering and technology education, as provided by NITs, can exacerbate stressors, making it vital to address the psychological well-being of students in this context (Negi, Khanna, & Aggarwal, 2019). The significance of investigating and addressing the psychological well-being of students at NIT Srinagar Garhwal, and in similar institutions, cannot be overstated. Research indicates a strong connection between psychological well-being and academic success, personal development, & overall quality of life (Lyubomirsky et al., 2005; Suldo et al., 2013). Improving the psychological well-being of students is crucial not just for their individual growth and satisfaction but also contributes to creating a conducive learning environment, promoting better academic outcomes, and nurturing well-rounded individuals who can positively contribute to society (Schonert-Reichl, 2017).

RESEARCH PROBLEM

The main research problem explored in this study is "To investigate the impact of mindfulness meditation on the psychological well-being of students enrolled in NIT Srinagar Garhwal, Uttarakhand." Although the positive impacts of mindfulness meditation on mental health are well-documented in diverse settings, there is a scarcity of empirical studies that focus on the student body at NIT Srinagar Garhwal. This research problem arises from the need to address the well-being of students in an academic environment where the pressures and challenges they face can significantly affect their mental health.

RESEARCH OBJECTIVES

This study has the following research objectives:

- 1. To design and implement a mindfulness meditation intervention program for the selected group of students.
- 2. To analyze the data and determine the effectiveness of mindfulness meditation in enhancing psychological well-being.

Hypothesis

Ho: There is no significant difference in the post-intervention outcome variable means among the groups, after controlling for the pre-intervention scores (covariate).

LITERATURE REVIEW

Mindfulness meditation, a practice characterized by non-judgmental awareness and the deliberate focus on the moment at hand (Kabat-Zinn, 1994), has attracted significant attention for its potential to enhance psychological well-being and alleviate stress. Recent studies have advanced our comprehension of how mindfulness meditation influences individuals in diverse settings.





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Mindfulness Meditation and Psychological Well-being

Recent studies continue to provide compelling evidence regarding the favorable outcomes of mindfulness meditation on psychological health. Kabat-Zinn's (1994) introduction of Mindfulness-Based Stress Reduction (MBSR) demonstrated the potential for mindfulness techniques to alleviate stress and enhance overall well-being. More recent investigations have further corroborated these findings. For example, a study by Hölzel et al. (2011) used neuroimaging techniques to demonstrate that mindfulness meditation can lead to structural brain changes associated with improved well-being. This study suggests that mindfulness training may enhance psychological health on a neurological level. Additionally, research by Gu et al. (2020) performed a meta-analysis involving randomized controlled trials and discovered that mindfulness interventions significantly improved various aspects of psychological well-being, including reductions in anxiety and depression.

Students' Well-being in Academic Settings

The psychological well-being of students in academic environments remains a topic of increasing concern, particularly in the context of higher education. Students often encounter academic stress, financial pressures, and social challenges that can negatively affect their overall well-being and academic performance. Recent studies have investigated the specific challenges faced by students and explored interventions to address their psychological well-being. A study by Regehr et al. (2013) evaluated the effect of mindfulness-based interventions on reducing stress and improving the well-being of medical students. The results suggested that mindfulness training positively contributed to a reduction in stress levels and an improvement in the psychological well-being of the students. Another recent study by Cook-Cottone (2015) explored the integration of mindfulness practices in educational settings. The research emphasized the potential of mindfulness programs to enhance both students' well-being and their academic performance.

CONCLUSIONS

The updated literature review underscores the continued support for the favorable impacts of mindfulness meditation on psychological well-being, as well as the challenges faced by students in academic environments. Recent research further emphasizes the potential advantages of mindfulness interventions in enhancing the well-being of students, aligning with the objectives of this current research, which aims to examining the influence of mindfulness meditation on students at NIT Srinagar Garhwal, Uttarakhand.

METHODS

Participants

This study involved 120 undergraduate students who were registered at the National Institute of Technology (NIT) Srinagar Garhwal, Uttarakhand. The sample was selected through a random sampling method. Participants were informed about the study's purpose and willingly granted informed consent to take part. They were aged between 18 and 25 years, with no prior experience in formal mindfulness meditation.

- Inclusion criteria: Undergraduate students at NIT Srinagar Garhwal, Uttarakhand.
- Exclusion criteria: Students with prior experience in mindfulness meditation or those with any known psychological disorders.

Experimental Design

This study utilized a design involving pretest-posttest measures with a control group design. The 120 participants were allocated randomly into two groups: one being the experimental group (n=60) and the other being the control group (n=60). The experimental group received a structured mindfulness meditation intervention, while the control group remained without any form of intervention.





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MATERIALS

Psychological Well-Being Scale, designed by D.S. Sisodia and Pooja Choudhary in 2012, comprises 50 items that cover five dimensions: sociability, satisfaction, mental health, efficiency, and interpersonal relations. It exhibited robust test-retest reliability, with a score of 0.87, and a high overall consistency value of 0.90. The scale also demonstrated a satisfactory level of content validity, supported by an external criteria coefficient of 0.94. Importantly, this scale is suitable for administration across various age groups.

Mindfulness Meditation Program: The mindfulness meditation program used in this study was constructed upon the Mindfulness-Based Stress Reduction (MBSR) protocol pioneered by Jon Kabat-Zinn (Kabat-Zinn, 1990). The intervention consisted of eight weekly sessions, each lasting approximately 90 minutes. Participants engaged in various mindfulness meditation exercises, including breath awareness, body scanning, and mindful awareness of thoughts and emotions.

Procedure

In this study, participants were recruited from NIT Srinagar Garhwal through the use of announcements and posters, ensuring their informed consent was obtained. Before the intervention began, all participants underwent a pre-intervention assessment in which they completed a psychological well-being questionnaire. The core of the study involved a mindfulness meditation intervention, specifically administered to the treatment group in accordance with a structured protocol. Members of this group were enrolled in an 8-week mindfulness meditation program, involving weekly group sessions led by a qualified mindfulness instructor. These sessions, which spanned approximately 60 minutes each, included a combination of guided mindfulness meditation exercises, discussions on mindfulness principles, and assignments for mindfulness practice at home. Participants were encouraged to dedicate at least 15 minutes daily to mindfulness meditation throughout the intervention period. Following the intervention, both the experimental and control groups were subjected to a post-intervention assessment, involving the completion of the psychological well-being questionnaire once again.

Data Analysis

The data gathered in this study was examined through the use of Analysis of Covariance (ANCOVA). ANCOVA was employed to assess the significance of any differences in psychological well-being between the experimental and control groups following the intervention while controlling for pre-intervention scores. This statistical analysis helped determine whether the mindfulness meditation intervention had a significant impact on the psychological well-being of students at NIT Srinagar Garhwal, Uttarakhand.

RESULTS

Descriptive Statistics

Descriptive statistics were calculated to summarize the psychological well-being scores for both the experimental and control groups, both before and after the mindfulness meditation intervention. The following table displays the means & standard deviations for each variable and group: "Descriptive statistics were computed to summarize the psychological well-being scores of participants in both the experimental and control groups, both before and after the mindfulness meditation intervention. In the experimental group, the mean psychological well-being score before the intervention was 164.73 (SD = 7.34), and after the intervention, it increased to 176.80 (SD = 12.59). Conversely, in the control group, the mean psychological well-being score before the intervention was 163.48 (SD = 6.88), and after the intervention, it remained relatively stable at 163.70 (SD = 8.82). These descriptive statistics suggest that the mindfulness meditation intervention had a notable impact on the psychological well-being of participants in the experimental group compared to those in the control group."





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Inferential Statistics

Inferential statistics were used to evaluate the influence of the mindfulness meditation intervention on the participant's psychological well-being. The model's Type III Sum of Squares is presented below: "The analysis of between-subjects effects examined the influence of the mindfulness meditation intervention on participants' psychological well-being, as measured post-intervention. The results indicate that the entire model exhibited statistical significance (F(2, 117) = 22.962, P < 0.001), accounting for approximately 28.2% of the variance in psychological well-being scores. This suggests that the mindfulness meditation intervention had a significant impact on psychological well-being. The individual components of the model were also examined. The 'Group' factor was found to be a significant contributor (F(1, 117) = 41.967, P < 0.001), indicating that the experimental and control groups had different post-intervention psychological well-being scores. The 'Psychological Well-Being Pre' variable, measuring pre-intervention psychological well-being, was not found to be statistically significant in predicting post-intervention scores (F(1, 117) = 1.987, P = 0.161). These results highlight the substantial impact of the mindfulness meditation intervention on participants' post-intervention psychological well-being, rejecting the Null hypothesis that "There is no significant difference in the post-intervention outcome variable means among the groups, after controlling for the pre-intervention scores (covariate)."

DISCUSSIONS

Interpretation of Results

The results of this study demonstrate a statistically significant influence of the mindfulness meditation intervention on the psychological well-being of students enrolled at NIT Srinagar Garhwal, Uttarakhand. The analysis of covariance (ANCOVA) results revealed that the model, accounting for 28.2% of the variance in post-intervention psychological well-being scores, was statistically significant (F (2, 117) = 22.962, p < 0.001)(Kingston, Chadwick, Meron, & Skinner, 2007). This implies that the mindfulness meditation intervention yielded a substantial positive effect on participants' psychological well-being, supporting our research hypothesis. The experimental group exhibited a noteworthy increase in psychological well-being scores following the intervention, highlighting the potential value of mindfulness meditation as a tool for enhancing psychological well-being among students.

Comparison with Previous Research

These findings align with prior research that has emphasized the advantageous outcomes of mindfulness meditation on psychological well-being (Nyklíček & Kuijpers, 2008). Numerous studies have reported similar outcomes, indicating that mindfulness practices can lead to reduced stress, improved emotional regulation, and enhanced well-being (Carroll, et al., 2022). The results are consistent with prior research, which highlights the favorable effects of mindfulness meditation on diverse groups, such as college students. (Zollars, Poirier, & Pailden, 2019).

Implications for Practice

The implications of this study are particularly relevant for educational institutions like NIT Srinagar Garhwal. Incorporating mindfulness meditation programs into the curriculum or offering them as extracurricular activities may enhance students' well-being and their capacity to manage the challenges of academic life. These findings indicate that advocating mindfulness practices can be a valuable strategy for fostering mental health and well-being among students.

Limitations of the Study

It's crucial to acknowledge the drawback of this research. First, the research's duration was relatively short (8 weeks), and long-term effects of mindfulness meditation were not explored. Additionally, the study's sample was limited to a specific demographic—undergraduate students at NIT Srinagar Garhwal, which may restrict generalizability. Future research should consider more extended intervention periods and a broader range of participants to improve external validity of the study.





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Suggestions for Future Research

To build on the current study, subsequent research could investigate the enduring consequences of mindfulness meditation interventions on psychological well-being. Additionally, investigating the impact of mindfulness on various elements of student life, such as academic achievement and stress reduction, could yield valuable insights. Comparative studies between different meditation techniques or group sizes may also provide a deeper understanding of the most effective approaches for enhancing psychological well-being among students (Nyklíček & Kuijpers, 2008).

CONCLUSIONS

In conclusion, this research emphasizes the potential of mindfulness meditation as a method to promote psychological well-being among undergraduate students. The results indicate that integrating mindfulness practices into educational settings may offer a promising avenue for improving students' mental health and well-being. Nonetheless, additional research is necessary to gain a comprehensive understanding of the enduring consequence and diverse applications of mindfulness in an academic context.

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Table 1: Descriptive Statistics for Psychological Well-being Scores

	Group			Std. Deviation
Ermanina antal	PsychologicalWell-BeingPre		164.7333	7.33893
Experimental	PsychologicalWell-Being Post		176.8000	12.58975
Combral	PsychologicalWell-Being Pre	60	163.4833	6.87538
Control	PsychologicalWell-Being Post	60	163.7000	8.82082

Table 2: ANCOVA Results for Psychological Well-Being Post

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5381.068a	2	2690.534	22.962	.000	.282
Intercept	4201.478	1	4201.478	35.857	.000	.235
Psychological Well-Being Pre	232.768	1	232.768	1.987	.161	.017
Group	4917.441	1	4917.441	41.967	.000	.264
Error	13709.432	117	117.175			
Total	3497298.000	120				
Corrected Total	19090.500	119				
	a. R Squared = .282 (Ac	djusted	R Squared = .27	(0)		_





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RESEARCH ARTICLE

e-Connectedness on P-Cubic Topological Spaces

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ABSTRACT

The aim of this paper is to introduce several types of e-connectedness in P-cubic topological spaces. This construction is based on the idea of cubic sets developed by Y.B.Jun. We also investigate some interrelations between these types of connectedness with some examples.

Keywords: CS_Pe -connected, CS_PeC_5 -connected, CS_Pe -strongly connected, CS_PeC_M -disconnected, CS_PeC_5 connected, CS_Pe-extremally disconnected.

AMS (2000) subject classification:54A40, 54A99, 03E72, 03E99.

INTRODUCTION

The concepts of fuzzy set and interval-valued fuzzy set (IVFS) were introduced by Zadeh [8],[9]. Fuzzy topological space was introduced by C. L. Chang [3] in 1968. Using the concept of fuzzy sets and interval valued fuzzy sets in 2012, Y. B. Jun [4] introduced a new set called cubic set. The topological structure was constructed by Akhtar [1], in 2016 on cubic set theory called cubic topological space and discussed about two types such as P-cubic topological space and R-cubic topological space. In 2019, Loganayaki and Jayanthi[6] introduced interior and closure in P-cubic topological space and R-cubic topological space. Also they have introduced various types of open sets and continuous mappings on P-cubic and R-cubic topological spaces. The objective of this paper is to introduce several





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types of *e*-connectedness in *P*-cubic topological spaces. We also investigate some interrelations between these types of connectedness with some examples.

PRELIMINARIES

The basic definitions and the properties of neutrosophic soft topological spaces are discussed in this section.

Definition 2.1 [9] A closed sub-interval of I = [0,1] is called interval number. $a = [a^-, a^+]$ where $0 \le a^- \le a^+ \le 1$. [I] denotes the set of all interval numbers.

Definition 2.2 [9] Let X be a non-empty set. A function $A: X \to [I]$, from X to all interval number is called interval valued fuzzy set (IVFS) in X. $[I]^X$ denotes the set of all IVFS in X. $\forall A \in [I]^X$ and $x \in XA(x) = [A^-(x), A^+(x)]$ is called degree of membership of x in A. individually $A^-: X \to I$ and $A^+: X \to I$ is Fuzzy set in X. Simply A^- is called lower fuzzy set and A^+ is called upper fuzzy set.

Definition 2.3 [4] Let X be a non-empty set, Then a structure $A = \{\langle x, \mu(x), \lambda(x) \rangle / x \in X\}$ is cubic set in X in which μ is interval valued fuzzy set (IVFS) in X and λ is fuzzy set in X. Simply a cubic set is denoted by $A = \langle \mu, \lambda \rangle$ and C^X denotes the collection of all cubic sets in X.

Definition 2.4 [4] Let $X \neq \varphi$, Then a cubic set $A = \langle \mu, \lambda \rangle$ is said to be internal cubic set (ICS) if $\mu^-(x) \leq \lambda(x) \leq \mu^+(x) \forall x \in X$.

Defintion 2.5 [4] Let $X \neq \varphi$, Then a cubic set $A = \langle \mu, \lambda \rangle$ is said to be an external cubic set (ECS) if $\lambda(x) \not\in (\mu^-(x), \mu^+(x)) \forall x \in X$.

A cubic set $A = \langle \mu, \lambda \rangle$ in which $\mu(x) = 0$ and $\lambda(x) = 1$ (resp. $\mu(x) = 1$ and $\lambda(x) = 0$) $\forall x \in X$ is denoted by $\ddot{0}$ (resp. $\ddot{1}$).

A cubic set $A = \langle \mu, \lambda \rangle$ in which $\mu(x) = 0$ and $\lambda(x) = 0$ (resp. $\mu(x) = 1$ and $\lambda(x) = 1 \forall x \in X$ is denoted by $\hat{0}$ (resp. $\hat{1}$).

Let $A = \langle \mu, \lambda \rangle$ and $B = \langle \beta, \eta \rangle$ be two cubic sets in X, Then we define;

- 1. $A = B \Leftrightarrow \mu = \beta$ and $\lambda = \eta$
- 2. $A \subseteq_P B \Leftrightarrow \mu \subseteq \beta$ and $\lambda \leq \eta$
- 3. $A^c = \overline{A} = \langle \mu^c, 1 \lambda \rangle = \{\langle x, \mu^c(x), 1 \lambda(x) \rangle / x \in X\}$
- 4. $(A^c)^c = (\overline{A}) = A$
- 5. $\hat{0}^c = \hat{1}$ and $\hat{1}^c = \hat{0}$
- 6. $(\bigcup_P A_i)^c = \bigcap_P A_i^c$ and $(\bigcap_P A_i)^c = \bigcup_P A_i^c$
- 7. P-Union $\bigcup_{i\in\mathbb{N}} A = \{(x, (\bigcup_{i\in\mathbb{N}} \mu_i)(x), (\vee \lambda_i)i \in \mathbb{N}(x)/x \in X)\}$
- 8. P-Intersection $\bigcap_{i\in\mathbb{N}} A = \{ \langle x, (\bigcap_{i\in\mathbb{N}} \mu_i)(x), i\in\mathbb{N}(\Lambda\lambda_i)(x)/x \in X \rangle \}$

Definition 2.6 [1] A P- cubic topology (in brief Pct) is the family \mathcal{F}_p of cubic sets in X which satisfies the following conditions;

- 1. $\hat{0}$, $\hat{1} \in \mathcal{F}_{p}$.
- 2. Let $A_i \in \mathcal{F}_p$, Then $\bigcup_P A_i \in \mathcal{F}_p$. $i \in \mathbb{N}$
- 3. Let A, B $\in \mathcal{F}_p$, Then A \cap_P B $\in \mathcal{F}_p$.

The pair (X, \mathcal{F}_p) is called P-cubic topological space (in brief, Pcts).

Definition 2.7 [6] A set R is said to be a P-order Cubic set (in brief, CS_P) [(i)]

- 1. regular open set (briefly, $CS_P\delta ros$) if $R = CS_P int(CS_P clR)$.
- 2. regular closed set (briefly, $CS_P\delta rcs$) if $R = CS_Pcl(CS_PintR)$.





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Definition 2.8 [6] A set R is said to be a CS_P [(i)]

- 1. interior(resp. δ interior) of R (briefly, CS_PintR (resp. $CS_P\delta int$)) is defined by CS_PintR (resp. $CS_P\delta int$) = $\bigcup \{\tilde{G}: \tilde{G} \subseteq R\&\tilde{G} \text{ is a } CS_Pos \text{ (resp. } CS_P\delta os \text{) in } X\}.$
- 2. closure(resp. δ closure) of R (briefly, CS_PclR (resp. $CS_P\delta cl$)) is defined by CS_PclR (resp. $CS_P\delta cl$) = \bigcap { $\tilde{G}: \tilde{G} \supseteq R\&\tilde{G}$ is a CS_Pcs (resp. $CS_P\delta cs$) in X}.

Definition 2.9[7] A set R is said to be a CS_P [(i)]

- 1. δ -pre open set (briefly, $CS_P\delta Pos$) if $R \subseteq CS_Pint(CS_P\delta clR)$.
- 2. δ -semi open set (briefly, $CS_P\delta\delta so$) if $R \subseteq CS_Pcl(CS_P\delta intR)$.
- 3. *e*-open set (briefly, CS_Peos) if $R \subseteq CS_Pcl(CS_P\delta intR) \cup CS_Pint(CS_P\delta clR)$.
- 4. e^* -open set (briefly, CS_Pe^*os) if $R \subseteq CS_Pcl(CS_Pint(CS_P\delta clR))$.
- 5. a-open set (briefly, CS_Paos) if $R \subseteq CS_Pint(CS_Pcl(CS_P\delta intR))$.

The complement of a CS_Pe -open set (resp. $CS_P\delta os$, $CS_P\delta Pos$, $CS_P\delta sak CS_Pe^*os$) is called a neutrosophic soft e- (resp. δ , δ -pre, δ -semi & e^*) closed set (briefly, CS_Pecs (resp. $CS_P\delta csCS_P\delta Pcs$, $CS_P\delta sak CS_Pe^*cs$)) in X. The family of all $CS_P\delta Pos$ (resp. $CS_P\delta Pcs$, $CS_P\delta Sos$, $CS_P\delta Sos$, $CS_P\delta Sos$, CS_Pecs , CS_Pecs (S_Pecs) of S is denoted by $SS_P\delta Pos$ (resp. $SS_P\delta Pos$), $SS_P\delta Pos$ ($SS_P\delta Pos$), $SS_P\delta Sos$), $SS_P\delta Sos$ ($SS_P\delta Sos$), $SS_P\delta Sos$), $SS_P\delta Sos$ ($SS_P\delta Sos$), $SS_P\delta Sos$), $SS_P\delta Sos$ ($SS_P\delta Sos$), $SS_P\delta Sos$), $SS_P\delta Sos$ 0 ($SS_P\delta Sos$), $SS_P\delta Sos$ 0 ($SS_P\delta Sos$ 0), $SS_P\delta Sos$ 0 ($SS_P\delta Sos$ 0).

Definition 2.10 [7] A set R is said to be a CS_P [(i)]

- 1. *e* interior(resp. δpre interior & $\delta semi$ interior) of R (briefly, CS_PeintR (resp. $CS_P\delta \mathcal{P}int\&CS_P\delta Sint$)) is defined by CS_PeintR (resp. $CS_P\delta \mathcal{P}int\&CS_P\delta Sint$) = \bigcup { $\tilde{G}: \tilde{G} \subseteq R\&\tilde{G}$ is a CS_Peos (resp. $CS_P\delta \mathcal{P}os\&CS_P\delta Sos$) in X}.
- 2. e closure (resp. δpre closure & $\delta semi$ closure) of R (briefly, CS_PeclR (resp. $CS_P\delta\mathcal{P}cl\&CS_P\delta\mathcal{S}cl$)) is defined by CS_PeclR (resp. $CS_P\delta\mathcal{P}cl\&CS_P\delta\mathcal{S}cl$) = \bigcap { $\tilde{G}: R \subseteq \tilde{G}\&R$ is a CS_Pecs (resp. $CS_P\delta\mathcal{P}cs\&CS_P\delta\mathcal{S}cs$) in X}.

Various types of *P*-order *e*-connectedness in cubic topological spaces

Definition 3.1 An Pcts(X, \mathcal{F}_P) is CS_P e-disconnected if there exists CS_P eosP, Q in X, P $\neq \hat{0}$, Q $\neq \hat{0}$ such that P \cup Q = $\hat{1}$ and P \cap Q = $\hat{0}$. If X is not CS_P e-disconnected then it is said to be CS_P e-connected.

Example 3.1 Let X be a non-empty set and \mathcal{F}_p be the collection of P-order cubic sets in X then (X, \mathcal{F}_p) be P-cubic topological space $\{\hat{0}, \hat{1}, A_1, A_2, A_3, A_4\}$ where $A_1 = \langle [0.2, 0.4], 0.3 \rangle$, $A_2 = \langle [0.3, 0.5], 0.5 \rangle$, $A_3 = \langle [0.6, 0.8], 0.7 \rangle$, $A_4 = \langle [0.8, 0.9], 0.9 \rangle$, A_2 and A_4 are CS_p eos in $X, A_2 \neq \hat{0}$, $A_4 \neq \hat{0}$ and $A_2 \cup A_4 = A_4 \neq \hat{1}$ and $A_2 \cap A_4 = A_2 \neq \hat{0}$. Hence X is CS_p econnected.

Example 3.2 In Example 2.1 Consider the cubic set $A_5 = \langle [0,1], 0 \rangle$, $A_6 = \langle [1,0], 1 \rangle$ are $CS_P eos$ in X, $A_5 \neq \hat{0}$ and $A_6 \neq \hat{0}$ and $A_5 \cup A_6 = \hat{1}$, $A_5 \cap A_6 = \hat{0}$. Hence X is $CS_P e$ -connected

Definition 3.2 An Pcts(X, \mathcal{F}_p) is CS_PeC_5 -disconnected if there exists CSP in X, which is both CS_Pecs and CS_Pecs such that $P \neq \hat{0}$, and $P \neq \hat{1}$. If X is not CS_PeC_5 -disconnected then it is said to be CS_PeC_5 -connected.

Example 3.3 In Example 2.1 Consider the cubic set $A_5 = \{[0.3,0.5],0.5\}$ is a CS_P eos but not CS_P ecs

Example 3.4 In Example 2.1 Consider the cubic set $A_5 = \langle [0.6,0.8],0.7 \rangle$ which is a $CS_P eos$ also $CS_P eos$ such that $\hat{1} \neq A_5 \neq \hat{0}$. Thus $XCS_P eC_5$ -connected.

Proposition 3.1 CS_PeC₅-connectedness implies CS_Pe-connectedness.

Proof. Suppose that there exists nonempty CS_PeosP and Q such that $P \cup Q = \hat{1}$ and $P \cap Q = \hat{0}(CS_Pe$ -disconnected). In other words $\overline{Q} = P$. Hence P is CS_Pe -clopen which implies X is CS_PeC_5 -disconnected. But the converse need not be true as shown by the following example.





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Example 3.5 In Example 2.1 Consider the cubic set $A_5 = \langle [0.6,0.8],0.7 \rangle$, $A_6 = \langle [0.3,0.5],0.5 \rangle$, A_5 and A_6 are $CS_P eos$ in X. Also $A_5 \cup A_6 = A_5 \neq \hat{1}$, $A_5 \cap A_6 = A_6 \neq \hat{0}$. Hence X is $CS_P e$ -connected. Since A_5 is both $CS_P eos$ and $CS_P eos$ in X, X is $CS_P eC_5$ -disconnected.

Proposition 3.2 Let $f: (X, T) \to (Y, S)$ be a CS_Pe -irresolute surjection, (X, \mathcal{F}_p) is an CS_Pe -connected, then (Y, S) is CS_Pe -connected.

Proof. Assume that (Y,S) is not CS_Pe -connected then there exists nonempty CS_PeosP and Q in (Y,S) such that $P \cup Q = \hat{1}$ and $P \cap Q = \hat{0}$. Since f is CS_Pe -irresolute mapping, $R = f^{-1}(P) \neq \hat{0}$, $U = f^{-1}(Q) \neq \hat{0}$ which are CS_Peos in X. And $f^{-1}(P) \cup f^{-1}(Q) = f^{-1}(\hat{1}) = \hat{1}$ which implies $R \cup U = \hat{1}$. $f^{-1}(P) \cap f^{-1}(Q) = f^{-1}(\hat{0}) = \hat{0}$ which implies $R \cap U = \hat{0}$. Thus X is CS_Pe -connected, which is a contradiction to our hypothesis. Hence Y is CS_Pe -connected.

Proposition 3.3 (X, \mathcal{F}_p) is $CS_p eC_5$ -connected iff there exists no nonempty $CS_p eos P$ and Q in X such that $P = \overline{Q}$ **Proof.** Suppose that P and Q are $CS_p eos$ in X such that $P \neq \hat{0} \neq Q$ and $P = \overline{Q}$. Since $P = \overline{Q}$, \overline{Q} is an $CS_p eos$ and Q is an $CS_p eos$, and $P \neq \hat{0}$ implies $Q \neq \hat{1}$. But this is a contradiction to the fact that X is $CS_p eC_5$ -connected. Conversely, let P be both $CS_p eos$ and $CS_p eos$ in X such that $\hat{0} \neq P \neq \hat{1}$. Now take $Q = \overline{P}$. Q is an $CS_p eos$ and $P \neq \hat{1}$ which implies $Q = \overline{P} \neq \hat{0}$ which is a contradiction.

Definition 3.3 An Pcts(X, \mathcal{F}_p) is CS_Pe-strongly connected if there exists no nonempty CS_PecsP and Q in X such that $P \cap Q = \hat{Q}$.

Proposition 3.4 An Pcts(X, \mathcal{F}_p) is CS_Pe-strongly connected if there exists no CS_PeosP and Q in X, P \neq $\hat{1} \neq$ Q such that P \cap Q = $\hat{0}$.

Example 3.6 In Example 2.1 Consider the cubic set $A_5 = \langle [0.2,0.4],0.3 \rangle$, $A_6 = \langle [0.6,0.8],0.7 \rangle$, A_5 is a $CS_P eos$. A_5 , A_6 is a $CS_P eos$. Hence X is $CS_P eos$. Hence X is $CS_P eos$.

Proposition 3.5 Let $f:(X,T) \to (Y,S)$ be a CS_Pe -irresolute surjection. If X is an CS_Pe -strongly connected, then so is Y. **Proof.** Suppose that Y is not CS_Pe -strongly connected then there exists CS_PecSC and D in Y such that $C \neq \hat{0}, D \neq \hat{0}, C \cap D = \hat{0}$. Since f is CS_Pe -irresolute, $f^{-1}(C), f^{-1}(D)$ are CS_PecS in X and $f^{-1}(C) \cap f^{-1}(D) = \hat{0}, f^{-1}(C) \neq \hat{0}, f^{-1}(D) \neq \hat{0}$. (If $f^{-1}(C) = \hat{0}$, then $f(f^{-1}(C)) = C$ which implies $f(\hat{0}) = C$. So $C = \hat{0}$ a contradiction) Hence X is CS_Pe -strongly disconnected, a contradiction. Thus (Y,S) is CS_Pe -strongly connected. CS_Pe -strongly connected does not imply CS_PeC_S -connected, and CS_PeC_S -connected does not imply CS_Pe -strongly connected. For this purpose we see the following examples:

Example 3.7 In Example 2.1 Consider the cubic set $A_5 = \langle [0.2,0.4],0.3 \rangle$, X is $CS_P e C_5$ -connected. Hence X is $CS_P e C_5$ -connected. But X is not $CS_P e C_5$ -connected since A_5 is $CS_P e c c$ and $CS_P e c c$ in X.

Example 3.8 In Example 2.1 Consider the cubic set $A_5 = \langle [0.8,0.9],0.9 \rangle$, $A_6 = \langle [0.3,0.5],0.5 \rangle$, X is CS_PeC_5 -connected. But X is not CS_Pe -strongly connected since A_5 , A_6 are CS_Peos in X.

Definition 3.4P and Q are non-zero intuitionistic fuzzy sets in (X, \mathcal{F}_D) . Then P and Q are said to be

- 1. CS_Pe -weakly separated if $CS_PeclP \subseteq \overline{Q}$ and $CS_PeclQ \subseteq \overline{P}$.
- 2. $CS_P e q$ -separated if $(CS_P e c l P) \cap Q = \hat{0} = P \cap (CS_P e c l Q)$.

Definition 3.5 An $Pcts(X, \mathcal{F}_p)$ is said to be CS_PeC_S -disconnected if there exists CS_Pe -weakly separated non-zero intuitionistic fuzzy sets P and Q in (X, \mathcal{F}_p) such that $P \cup Q = \hat{1}$.





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Example 3.9 In Example 2.1 Consider the cubic set $A_5 = \langle [0,1], 0 \rangle$, $A_6 = \langle [1,0], 1 \rangle$ are $CS_P eos$ in $X.CS_P ecl(A_5) \subseteq A_6$ and $CS_P ecl(A_6) \subseteq A_5$. Hence A_5 and A_6 are $CS_P e$ -weakly separated and so X is $CS_P eC_S$ -disconnected

Definition 3.6 An Pcts(X, \mathcal{F}_p) is said to be CS_PeC_M -disconnected if there exists CS_Pe -q-separated non-zero intuitionistic fuzzy sets P and Q in (X, \mathcal{F}_p) such that $P \cup Q = \hat{1}$.

Example 3.10 In Example 2.1 Consider the cubic set $A_5 = \langle [0,1], 0 \rangle$, $A_6 = \langle [1,0], 1 \rangle$ are $CS_P e c in X$. $CS_P e$

Remark 3.1 An Pcts(X, \mathcal{F}_p) is CS_PeC_S-connected if and only if (X, \mathcal{F}_p) is CS_PeC_M-connected.

Definition 3.7 An Pcts(X, \mathcal{F}_p) is said to be CS_Pe-super disconnected if there exists an CS_PerosP in X such that $\hat{0} \neq P \neq \hat{1}$. X is called CS_Pe-super connected if X is not CS_Pe-super disconnected.

Example 3.11 In Example 2.1 Consider the cubic sets $A_5 = \langle [0.2,0.4],0.3 \rangle$, $A_6 = \langle [0.6,0.8],0.4 \rangle$, A_5,A_6 are $CS_P eos's$ in X and $CS_P ecl(CS_P eint(A_5)) = A_5$. This implies A_5 is a $CS_P ecl(CS_P eint(A_5)) = A_5$.

Proposition 3.6 Let (X, \mathcal{F}_p) be an Pcts. Then the following are equivalent:

- 1. X is $CS_P e$ -super connected
- 2. For each $CS_PeosP \neq \hat{0}$ in X, we have $CS_PeclP = \hat{1}$
- 3. For each $CS_PecsP \neq \hat{1}$ in X, we have $CS_PeintP = \hat{0}$
- 4. There exists no CS_PeosP and Q in X such that $P \neq \hat{0} \neq Q$ and $P \subseteq \overline{Q}$
- 5. There exists no CS_PeosP and Q in X such that $P \neq \hat{0} \neq Q$, $Q = \overline{CS_PeclP}$ and $P = \overline{CS_PeclQ}$
- 6. There exists no CS_PecsP and Q in X such that $P \neq \hat{1} \neq Q$, $Q = \overline{CS_PeintP}$ and $P = \overline{CS_PeintQ}$

Proof. (i) \Rightarrow (ii): Assume that there exists an $P \neq \hat{0}$ such that $CS_PeclP \neq \hat{1}$. Take $P = CS_Peint(CS_PeclP)$. Then P is proper CS_Peros in X which contradicts that X is CS_Pe -super connectedness. (ii) \Rightarrow (iii): Let $P \neq \hat{1}$ be an CS_Pecs in X. If we take $Q = \overline{P}$ then Q is an CS_Pecs in X and $Q \neq \hat{0}$. Hence by

- (ii) $CS_PeclQ = \hat{1} \Rightarrow \overline{CS_PeclQ} = \hat{0} \Rightarrow CS_Peint(\overline{Q}) = \hat{0} \Rightarrow CS_PeintA = \hat{0}$.
- (iii) \Rightarrow (iv): Let P and Q are CS_Peos in X such that $P \neq \hat{0} \neq Q$ and $P \subseteq \overline{Q}$. Since \overline{Q} is an CS_Pecs in $X, \overline{Q} \neq \hat{1}$ by (iii) $CS_Peint(\overline{Q}) = \hat{0}$. But $P \subseteq \overline{Q}$ implies $\hat{0} \neq P = CS_Peint(P) \subseteq CS_Peint(\overline{Q}) = \hat{0}$ which is a contradiction.
- (iv) \Rightarrow (i): Let $\hat{0} \neq P \neq \hat{1}$ be an CS_Peros in X. If we take $Q = \overline{CS_PeclP}$, we get $Q \neq \hat{0}$. (If not $Q = \hat{0}$ implies $\overline{CS_PeclP} = \hat{0} \Rightarrow CS_PeclP = \hat{1} \Rightarrow P = CS_Peint(CS_PeclP) = CS_Peint(\hat{1}) = \hat{1} \Rightarrow P = \hat{1}$ a contradiction to $P \neq \hat{1}$). We also have $P \subseteq \overline{Q}$ which is also a contradiction. Therefore X is CS_Pe -super connected.
- (i) \Rightarrow (v): Let P and Q be two CS_Peos in (X, \mathcal{F}_p) such that $P \neq \hat{0} \neq Q, Q = \overline{CS_PeclP}$ and $P = \overline{CS_PeclQ}$. Now we have $CS_Peint(CS_PeclP) = CS_Peint(\overline{Q}) = \overline{CS_PeclQ} = P, P \neq \hat{0}$ and $P \neq \hat{1}$, since if $P = \hat{1}$ then $\hat{1} = \overline{CS_PeclQ} \Rightarrow CS_PeclQ = \hat{0} \Rightarrow Q = \hat{0}$. But $Q \neq \hat{0}$. Therefore $P \neq \hat{1} \Rightarrow P$ is proper CS_Peros in (X, \mathcal{F}_p) which is contradiction to (i). Hence (v) is true.
- (v) \Rightarrow (i): Let P be CS_Peos in X such that $P = CS_Peint(CS_PeclP)$, $0_{\sim} \neq P \neq \hat{1}$. Now take $Q = \overline{CS_PeclP}$. In this case, we get $Q \neq \hat{0}$ and Q is an CS_Peos in X and $Q = \overline{CS_PeclP}$ and $\overline{CS_PeclQ} = \overline{CS_Pecl(\overline{CS_PeclP})} = \overline{(\overline{CS_PeclP})} = \overline{(CS_PeclP)} = P$. But this is a contradiction to (v). Therefore (X, \mathcal{F}_p) is CS_Pe -super connected space.
- (v) \Rightarrow (vi): Let P and Q be CS_Pecs in (X, \mathcal{F}_p) such that $P \neq \hat{1} \neq Q, Q = \overline{CS_PeintP}$ and $P = \overline{CS_PeintQ}$. Taking $C = \overline{P}$ and $D = \overline{Q}$, C and D become CS_Pecs in (X, \mathcal{F}_p) and $C \neq \hat{0} \neq D$, $\overline{CS_PeclC} = \overline{CS_Pecl(\overline{P})} = \overline{(CS_PeintP)} = CS_PeintP = \overline{Q} = D$ and similarly $\overline{CS_PeclD} = C$. But this is a contradiction to (v). Hence (vi) is true.(vi) \Rightarrow (i): We can prove this by the similar way as in (v) \Rightarrow (vi).

Proposition 3.7 Let $f: (X, T) \to (Y, S)$ be a CS_P e-irresolute surjection. If X is an CS_P e-super connected, then so is Y.





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Proof. Suppose that Y is CS_Pe -super disconnected. Then there exists CS_PeosC and D in Y such that $C \neq \widehat{0} \neq D$, $C \subseteq \overline{D}$. Since f is CS_Pe -irresolute, $f^{-1}(C)$ and $f^{-1}(D)$ are CS_Peos in X and $C \subseteq \overline{D}$ implies $f^{-1}(C) \subseteq f^{-1}(D) = \overline{f^{-1}(D)}$. Hence $f^{-1}(C) \neq \widehat{0} \neq f^{-1}(\overline{D})$ which means that X is CS_Pe -super disconnected which is a contradiction.

Definition 3.8 An Pcts(X, \mathcal{F}_p) is called CS_PeC₅-connected between two intuitionistic fuzzy sets P and Q if there is no IFOS E in (X, \mathcal{F}_p) such that P \subseteq E and E \overline{q} Q.

Example 3.12 In Example 2.1 Consider the cubic sets $A_5 = \langle [0.3,0.5],0.5 \rangle$, $A_6 = \langle [0.4,0.5],0.5 \rangle$ $A_7 = \langle [0.6,0.7],0.7 \rangle$, A_5 is $CS_P e c_5$ -connected between A_5 and A_6 .

Theorem 3.1 If an $Pcts(X, \mathcal{F}_p)$ is an CS_PeC_5 -connected between two P and Q, then it is CS_PC_5 -connected between two P and Q.

Proof. Suppose (X, \mathcal{F}_p) is not CS_PC_5 -connected between two P and Q then there exists an IFOS E in (X, \mathcal{F}_p) such that $P \subseteq E$ and $E\overline{q}Q$. Since every IFOS in CS_PeOS , there exists an CS_PeOS E in (X, \mathcal{F}_p) such that $P \subseteq E$ and $E\overline{q}Q$ which implies (X, \mathcal{F}_p) is not CS_Pe -connected between P and Q, a contradiction to our hypothesis. Therefore, (X, \mathcal{F}_p) is CS_PC_5 -connected between P and Q However, the converse of the above Theorem is need not be true, as shown by the following example.

Example 3.13 In Example 2.1 Consider the cubic sets $A_5 = \langle [0.1,0.2],0.2 \rangle$ $A_6 = \langle [0.3,0.4],0.3 \rangle$, A_5 is CS_P os in X. Then $(X, \mathcal{F}_P)CS_PC_5$ -connected between A_6 and A_7 . Consider $A_7 = \langle [0.3,0.5],0.5 \rangle$ is a CS_P eos such that $A_6 \leq A_7$ and $A_7 \leq \overline{A_6}$ which implies (X, \mathcal{F}_P) is CS_PC_5 -disconnected between A_5 and A_6 .

Theorem 3.2 Let (X, \mathcal{F}_p) be an Pcts and P and Q be in (X, \mathcal{F}_p) . If PqQ then (X, \mathcal{F}_p) is $CS_P eC_5$ -connected between P and Q. Proof. Suppose (X, \mathcal{F}_p) is not $CS_P eC_5$ -connected between P and Q. Then there exists an $CS_P eC_5$ E in (X, \mathcal{F}_p) such that $P \subseteq E$ and $E \subseteq \overline{Q}$. This implies that $P \subseteq \overline{Q}$. That is $P\overline{Q}Q$ which is a contradiction to our hypothesis. Therefore (X, \mathcal{F}_p) is $CS_P eC_5$ -connected between P and Q. However, the converse of the above Theorem is need not be true, as shown by the following example.

Example 3.14 In Example 2.1 Consider the cubic sets $A_5 = \langle [0.3,0.5],0.5 \rangle$ $A_6 = \langle [0.4,0.5],0.5 \rangle$ $A_7 = \langle [0.6,0.7],0.7 \rangle$, A_5 is $CS_P eos$ in X. Then (X, \mathcal{F}_P) is $CS_P eC_5$ -connected between A_5 and A_6 . But A_5 is not q-coincident with A_6 .

Definition 3.9 Let N be an IFS in Pcts(X, \mathcal{F}_n)

(a) If there exists $CS_P eosM$ and W in X satisfying the following properties, then N is called $CS_P eC_i$ -disconnected (i=1,2,3,4):

 $C_1: N \subseteq M \cup W, M \cap W \subseteq \overline{N}, N \cap M \neq \hat{0}, N \cap W \neq \hat{0},$

 $C_2: N \subseteq M \cup W, N \cap M \cap W = \hat{0}, N \cap M \neq \hat{0}, N \cap W \neq \hat{0},$

 $C_3: N \subseteq M \cup W, M \cap W \subseteq \overline{N}, M \not\subseteq \overline{N}, W \not\subseteq \overline{N}$

 $C_4: N \subseteq M \cup W, N \cap M \cap W = \hat{0}, M \not\subseteq \overline{N}, W \not\subseteq \overline{N},$

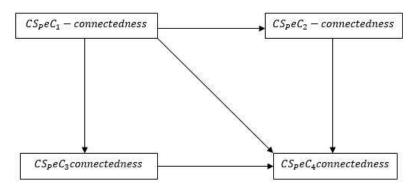
(b) N is said to be CS_PeC_i -connected (i = 1,2,3,4) if N is not CS_PeC_i -disconnected (i = 1,2,3,4).

Obviously, we can obtain the following implications between several types of CS_PeC_i -connected (i=1,2,3,4):





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Example 3.15 In Example 2.1 M = $\langle [0.3,0.5],0.5 \rangle$, W = $\langle [0.5,0.7],0.5 \rangle$ be CS_Peos. Consider the cubic set N = $\langle [0.4,0.7],0.4 \rangle$, N is CS_PeC₂, CS_PeC₃, CS_PeC₄-connected but CS_PeC₁-disconnected.

Example 3.16 In Example 2.1 M = $\langle [0,0.9],0 \rangle$, W = $\langle [0.8,0],0.8 \rangle$ be CS_Peos. Consider the cubic set N = $\langle [0,0.6],0.4 \rangle$, N is CS_PeC₂-disconnected but CS_PeC₄-connected.

Example 3.17 In Example 2.1 M = $\langle [0.6,0.7],0.7 \rangle$, W = $\langle [0,0.8],0.5 \rangle$ be CS_Peos. Consider the cubic set N = $\langle [0.3,0.6],0.5 \rangle$, N is CS_PeC₃-disconnected but CS_PeC₄-connected.

P-order e-Extremally Disconnectedness in Cubic Topological Spaces

Definition 4.1 Let (X, \mathcal{F}_P) be any Pcts. X is called CS_Pe -extremally disconnected if the e-closure of every CS_Peos in X is CS_Peos .

Theorem 4.1 For an Pcts(X, \mathcal{F}_P) the following are equivalent:

- 1. (X, \mathcal{F}_P) is an $CS_P e$ -extremally disconnected space.
- 2. For each CS_PecsP , $CS_Peint(P)$ is an CS_PeCS .
- 3. For each CS_PeosP , $CS_Pecl(P) = CS_Pecl(\overline{CS_Pecl(P)})$ is an CS_Pecs .
- 4. For each CS_PeosP and Q with $CS_Pecl(P) = \overline{Q}$, $CS_Pecl(P) = \overline{CS_PeclB}$.

Proof. (i) \Rightarrow (ii): Let P be any CS_Pecs . Then \overline{P} is an CS_Peos . So $CS_Pecl(\overline{P}) = \overline{CS_Peint(P)}$ is an CS_Peos . Thus $CS_Peint(P)$ is an CS_Pecs in (X, \mathcal{F}_P) .

(ii) \Rightarrow (iii): Let *P* be an CS_Peos . Then

 $CS_Pecl(\overline{CS_Pecl(P)}) = CS_Pecl(CS_Peint(\overline{P})). CS_Pecl(\overline{CS_Pecl(P)}) = CS_Pecl(CS_Peint(\overline{P})). Since P is an <math>CS_Peos. \overline{P}$ is an $CS_Peos. So$ by (ii) $CS_Peint(\overline{P})$ is an $CS_Pecs. So$ by (ii) $CS_Peint(\overline{P})$ is an $CS_Pecs. So$ that is $CS_Pecl(CS_Peint(\overline{P})) = CS_Peint(\overline{P}). Hence \overline{CS_Pecl(CS_Peint(\overline{P}))} = \overline{CS_Pecl(P)}.$

(iii) \Rightarrow (iv): Let P and Q be any two CS_Peos in (X, \mathcal{F}_P) such that $CS_Pecl(P) = \overline{Q}$. (iii) implies $CS_Pecl(P) = \overline{CS_Pecl(\overline{Q})} = \overline{CS_Pecl(\overline{Q})} = \overline{CS_Pecl(Q)}$.

(iv) \Rightarrow (i): Let P be any CS_Peos in (X, \mathcal{F}_P) . Put $Q = \overline{CS_Pecl(P)}$. Then $CS_Pecl(P) = \overline{Q}$. Hence by (iv) $CS_Pecl(P) = \overline{CS_Pecl(Q)}$. Therefore $CS_Pecl(P)$ is CS_Peos in (X, \mathcal{F}_P) . That is (X, \mathcal{F}_P) is an CS_Pe -extremally disconnected space.





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RESEARCH ARTICLE

g - Inverses of Interval Incline Matrices

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ABSTRACT

The classic examples of interval incline matrices are interval fuzzy matrices and interval lattice matrices; the g-inverse of interval incline matrices was studied, the development and presence of {1, 2}, {1,3} and {1,4} were investigated regarding the row spaces and column spaces.

Keywords: Incline, g – *inverse* of interval incline matrix, fuzzy matrices.

2020 mathematical science classification: 16Y60, 15B15

INTRODUCTION

Inclines are Special type of Semiring, Cao [1] introduced the notion and developed it by Co-authored with Kim and Roush. The characteristics of inclination matrices, which are a generalisation of distributive lattice, Boolean, and fuzzy algebra, and matrices, respectively, were also examined by the author in [2]. The fuzzy algebra g-inverses are studied in [2] by a number of asbects from a variety of fields [4, 7, 8, 10]. The regularity requirement for incline matrices, which is a generalisation of fuzzy matrices, was examined by Meenakshi and Shakila Banu [6]. Interval valued fuzzy matrices (IVFM) were studied in [6] and the regularity Condition of this domains examined by meenakshi and Kaliraja [5]. Interval incline matrices (IIM) is a new area of research and which has the Applications multicriteria automata theory and optimization theory and decision making. We must look at the extension of IVFM, the g-inverse of interval incline matrices. We examined the characteristics and further developed the construction of the {1,2}, {1,3}, and {1,4} inverses of interval inclined matrices, which are strongly oriented with respect to the row and column spaces of the IIM.





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PRELIMINARIES

The necessary definitions and some interval inclination matrix results from certain interval incline matrix results are shown in this section.

Definition 2.1

A set L that is not empty using binary actions (addition and multiplication) signified as and meeting the given requirements is called an inclination. typically, we hide the dot while during multiplication. for α , β , $\gamma \in L$,

- 1. $[\alpha_L, \alpha_U] + [\beta_L, \beta_U] = [\beta_L, \beta_U] + [\alpha_L, \alpha_U];$
- 2. $[\alpha_L, \alpha_U] + ([\beta_L, \beta_U] + [\gamma_L, \gamma_U]) = ([\alpha_L, \alpha_U] + [\beta_L, \beta_U]) + [\gamma_L, \gamma_U];$
- 3. $[\alpha_L, \alpha_U]([\beta_L, \beta_U][\gamma_L, \gamma_U]) = ([\alpha_L, \alpha_U][\beta_L, \beta_U])[\gamma_L, \gamma_U];$
- 4. $[\alpha_L, \alpha_U]([\beta_L, \beta_U] + [\gamma_L, \gamma_U]) = ([\alpha_L \beta_L, \alpha_U \beta_U]) + [\alpha_L \gamma_L, \alpha_U \gamma_U];$
- 5. $([\beta \iota, \beta u] + [\gamma \iota, \gamma u]) [\alpha \iota, \alpha u] = ([\beta \iota \alpha \iota, \gamma u \alpha u]) + [\gamma \iota \alpha \iota, \gamma u \alpha u];$
- 6. $[\alpha L, \alpha u] + [\alpha L, \alpha u] = [\alpha L, \alpha u];$
- 7. $[\alpha_L, \alpha_U] + [\alpha_L \gamma_L, \alpha_U \gamma_U] = [\alpha_L, \alpha_U];$
- 8. $[\gamma_L, \gamma_U] + [\alpha_L \gamma_L, \alpha_U \gamma_U] = [\gamma_L, \gamma_U];$

In an incline (L, +,.) using a relation of ordering \leq decribed as on L

 $[x_L, x_U] \le [y_L, y_U]$ or $x_L \le y_L$ and $x_U \le y_U$ if and only if

 $[x_L, x_U] + [y_L, y_U] = [y_L, y_U]$ for $[x_L, x_U]$, $[y_L, y_U] \in L$, by the incline axioms,

 $[x_L, x_U] + [x_L y_L, x_U y_U] = [x_L, x_U]$ and

 $[y_L, y_U] + [x_L y_L, x_U y_U] = [y_L, y_U]$ we get

 $[x_L y_L, x_U y_U] \le [x_L, x_U]$ and $[x_L y_L, x_U y_U] \le [y_L, y_U]$

Therefore, inclines are semi rings that are additively idempotent and whose products are either equal to or less than either factor. The following characteristics of this incline order connection are from (P1) and (P2):

For $[x_L, x_U]$, $[y_L, y_U] \in L$,

(P1): $[x_L + y_L, x_U + y_U] \ge [x_L, x_U]$ and $[x_L y_L, x_U y_U] \ge [y_L, y_U]$

(P2): $[x_L y_L, x_U y_U] \le [x_L, x_U]$ and $[x_L y_L, x_U y_U] \le [y_L, y_U]$.

Definition 2.2

A matrix $A \in L_{mn}$, is regular (r) iff there exists matrix $X \in L_{mn}$, such that AXA = A, $X \in A\{1\}$ and $A\{1\}$ represents the set of all inverse elements of A, denotes as g = inverses of A.

Lemma 2.3

Let L presents several IIM for $A,B \in L_{mn}$, the following is necessary:

$$(i) \Re(AB) \subseteq \Re(A)B \subseteq \Re(B)$$

$$(ii) C(AB) \subseteq C(A)$$

Lemma 2.4

Suppose L presents several IIM and $A,B \in L_{mn}$ If A is a regular (r) matrix followed by the subsequent holds:

$$(i) \Re(B) \subseteq \Re(A) \Leftrightarrow B = BA^{-}A, \text{ for each } A^{-} \in A\{1\}$$

$$(ii) \ C(B) \ \subseteq C(A) \Leftrightarrow B = AA^-B, for \ each \ A^- \in A\{1\}.$$

Definition 2.5

Let $A=[A_L, A_U] \in L_{mn}$. Then the interval element $[a_{ijL}, a_{ijU}]$ is called the $(i, j)^{th}$ entry of $[A_L, A_U]$. Let $[A_{i^*L}, A_{i^*U}]$ ($[A_{*jL}, A_{ijU}]$) denote the i^{th} row (column) of $[A_L, A_U]$. The row space $\Re([A_L, A_U]) V_n$ contains a subspace called A





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engendred by the rows $\{[A_{i*L}, A_{i*U}]\}$ of $[A_L, A_U]$. The column space $C([A_L, A_U])$ of $[A_L, A_U]$ of the subspace of interval vector V_m created by the column $\{[A_{iL}, A_{iU}]\}$ of $[A_L, A_U]$. The null space (O_L, A_U) is the set $\{[X_L, X_U] \mid [X_L, X_L, X_L] = [0, 0]\}$. Note that a row (O_L, A_U) vector is just an interval element of $V_n(V_n)$

Definition 2.6

For a set of interval incline matrices $A=[a_{ij}L, a_{ij}u]$ and $B=[b_{ij}L, b_{ij}u]$ in L_{mn} such that $A \le B$, the interval incline matrix $[A, B] = [a_{ij}, b_{ij}]$ is a structure that ij th entries is the limit incline with minimum threshold a_{ij} and maximum threshold b_{ij} . In specific for A=B, Interval incline matrix (IIM) [AL, Au] reduces to the interval incline matrix $A \in L_{mn}$ For $A=[AL, Au] = [a_{ij}L, a_{ij}u] \in (IIM)_{m \times n}$, clearly the interval incline matrix

 a_{ijL} and $a_{ijU} \in L_{mn}$ such that $a_{ijL} \le a_{ijU}$.

Consequently, by these means Definition (2.5) A matrix can be written as

 $A=[A_L, A_U]=[a_{ijL}, a_{ijU}]$

----(1)

where (a_{ijL}) =lower limit, (a_{ijL}) = upper limit

For $A=[a_{ijL}, a_{ijU}]$ and $B=[b_{ijL}, b_{ijU}]$ is of order $m \times n$ their addition represented by A+B distinct as ,

 $[A_L, A_U] + [B_L, B_U] = [a_{ijL}, a_{ijU}] + [b_{ijL}, b_{ijU}]$

$$= [a_{ijL} + b_{ijL}, a_{ijU} + b_{ijU}]$$
 -----(2

And their multiplication can be defined as,

 $[A_L, A_U][B_L, B_U] = (C_{ij})$

$$= \left[\sum_{k} a_{ikL} b_{kjL}, \sum_{k} a_{ikU} b_{kjU}\right] - - - - (3)$$

for $i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, p$

where $A = [AL, Au]_{m \times n}$ and $B = [BL, Bu]_{n \times p}$,

their product denoted by [AB]= [ALBL, AUBU] $m \times p$.

 $A \ge B$ iff $a_{ijL} \ge b_{ijL}$ and $a_{ijU} \ge b_{ijU}$ iff A + B = A

----(4).

In specific if $a_{ijL} = a_{ijU} \& b_{ijL} = b_{ijU}$, as a result, the given equation gives the standard interval incline matrices.

g- Inverses of Interval Incline matrices

This section looks at the g-inverses of interval incline matrices and how they relate to both the row and column spaces .

Definition 3.1

For $A = [A_L, A_U] \in (IIM)_{mn}$, if there exists $X = [X_L, X_U] \in L_{mn}$ such that

- 1. $AXA = A \Leftrightarrow [AL, Au][XL, Xu][AL, Au] = [AL, Au]$
- 2. $XAX=X \Leftrightarrow [X_L, X_U][A_L, A_U][X_L, X_U] = [X_L, X_U]$
- 3. $(AX)^T = (AX) \Leftrightarrow [(AL, XL)^T, (Au, Xu)^T] = [AL, XL, Au, Xu]$
- 4. $(XA)^T = (XA) \iff [(X_L, A_L)^T, (X_U, A_U)^T] = [X_L, A_L, X_U, A_U],$

at that moment X is known as a g- invers of A. X is assumed to σ inverse of A and X belongs to A{ σ }, if X satisfy σ equivalence wherever σ is a subset of {1, 2, 3, 4}.

Lemma 3.2

Let [AL, Au], [BL, Bu] be the two interval incline matrices, if the product [AL, BL, Au, Bu] is defined, then

$$\begin{bmatrix} \Re(A_L B_L) , \Re(A_U B_U) \end{bmatrix} = \begin{bmatrix} \Re(A_L) , \Re(A_U) \end{bmatrix} \begin{bmatrix} B_L, B_U \end{bmatrix} \subseteq \begin{bmatrix} \Re(B_L) , \Re(B_U) \end{bmatrix} \text{ and } \\ \begin{bmatrix} C(A_L B_L) , C(A_U B_U) \end{bmatrix} \subseteq \begin{bmatrix} C(A_L) , C(A_U) \end{bmatrix}.$$





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Proof

Any interval vector
$$[y_L, y_U] \in [\Re(A_L B_L), \Re(A_U B_U)]$$
 is of the form $[y_L, y_U] = [uA_L B_L, uA_U B_U]$ $= [x_L B_L, x_U B_U]$ Where $[x_L, x_U] = [uA_L, uA_U]$ $= [uA_L, uA_U] \in [\Re(A_L), \Re(A_U)]$ Hence, $[y_L, y_U] \in [\Re(A_L B_L), \Re(A_U B_U)]$. Thus, $[\Re(A_L B_L), \Re(A_U B_U)] = [\Re(A_L), \Re(A_U)][B_L, B_U] \subseteq [\Re(B_L), \Re(B_U)]$ $= [\Re(A_L B_L), \Re(A_U B_U)] = [\Re(A_L B_L), \Re(A_U B_U)]$ $= [\Re(A_L B_L), \Re(A_U B_U)]$ $= [\Re(A_L B_L), \Re(A_U B_U)]$ $= [\Re(A_L B_L), \Re(A_U B_U)]$ $= [\Re(A_L B_L), \Re(A_U B_U)]$ $= [\Re(A_L B_L), \Re(A_U B_U)]$ $= [\Re(A_L B_L), \Re(A_U B_U)]$

Lemma 3.3

For [AL, Au], $[BL, Bu] \in L_{mn}$, if [AL, Au] is a ordered interval incline matrix, then the succeeding holds:

$$\begin{array}{c} (i) \ \left[\ \mathfrak{R} \big(B_L \big), \mathfrak{R} \big(B_U \big) \right] \subseteq \left[\mathfrak{R} \big(A_L \big), \mathfrak{R} \big(A_U \big) \ \right] \ \text{iff} \left[\ B_L, B_U \ \right] = \left[\ B_L A_L^- A_L, B_U A_U^- A_U \ \right] \\ \text{for each} \ \left[\ A_L^-, \ A_U^- \ \right] \in A \big\{ 1 \big\} \ . \end{array}$$

Proof

$$\lceil \Re(B_L), \Re(B_U) \rceil \subseteq \lceil \Re(A_L), \Re(A_U) \rceil$$

 \Leftrightarrow [BL, Bu] = [XL AL, Xu Au]

 \Leftrightarrow [BL, Bu] = [XL AL A-L AL, Xu Au A-u Au]

Thus (i) holds.

(ii) $[C(B_L), C(B_U)] \subseteq [C(A_L), C(A_U)]$

 $\Leftrightarrow [B_L, B_U] = [A_L Y_L, A_U Y_U]$

 \Leftrightarrow [BL, Bu] = [AL A-L AL YL, Au A-u Au Yu]

 \Leftrightarrow [BL, Bu] = [AL A-L BL, Au A-u Bu]

Thus (ii) holds.

Lemma 3.4

For [AL, Au], $[BL, Bu] \in L_{mn}$, we have the following:

$$(i) \left[\Re(B_L), \Re(B_U) \right] \subseteq \left[\Re(A_L), \Re(A_U) \right]$$
iff $[B_L, B_U] = [X_L A_L, X_U A_U]$ for some $[X_L, X_U] \in L_m$

$$(ii)$$
 $\left[C(B_L), C(B_U)\right] \subseteq \left[C(A_L), C(A_U)\right]$ iff $[B_L, B_U] = [Y_L A_L, Y_U A_U]$ for some $[Y_L, Y_U] \in L_n$





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Proof

If $[B_L, B_U] = [X_L A_L, X_U A_U]$ the i^{th} row of $[X_L A_L, X_U A_U]$, that is

$$\left[X_{L}A_{L}, X_{U}A_{U} \right]_{i^{*}} = \sum_{j} \left[X_{ijL}A_{i^{*}L}, X_{ijU}A_{i^{*}U} \right] \in \left[\Re(A_{L}), \Re(A_{U}) \right]$$

Hence,
$$\left[\Re \left(B_{\scriptscriptstyle L}\right), \Re \left(B_{\scriptscriptstyle U}\right)\,\right] \subseteq \left[\Re \left(A_{\scriptscriptstyle L}\right), \Re \left(A_{\scriptscriptstyle U}\right)\,\right]$$

Conversely, suppose $\left[\Re\left(B_{L}\right),\Re\left(B_{U}\right)\right]\subseteq\left[\Re\left(A_{L}\right),\Re\left(A_{U}\right)\right]$, then each row of $\left[B_{L},B_{U}\right]$ is a linear combination of $\left[A_{L},A_{U}\right]$. Hence, $\left[B_{i^{*}L},B_{i^{*}U}\right]=\sum\left[X_{ijL}A_{i^{*}L},X_{ijU}A_{i^{*}U}\right]$ and from which it follows that $\left[B_{L},B_{U}\right]=\left[X_{L}A_{L},X_{U}A_{U}\right]$ Statement (ii) follows from (i) by using the facts $\left[C\left(A_{L}\right),C\left(A_{U}\right)\right]=\left[\Re\left(A_{L}^{T}\right),\Re\left(A_{U}^{T}\right)\right]$ and $\left[\left(XA\right)_{L}^{T},\left(XA\right)_{U}^{T}\right]=\left[A_{L}^{T}X_{L}^{T},A_{U}^{T}X_{U}^{T}\right]$

Lemma 3.5

If $A=[A_L, A_U] \in L_{mn}$ with $\left[\Re\left(A_L\right), \Re\left(A_U\right)\right] = \left[\Re\left(A_L^T A_L\right), \Re\left(A_U^T A_U\right)\right]$ at that moment $\left[A_L^T A_L, A_U^T A_U\right]$ is regular interval incline matrix iff $A=[A_L, A_U]$ is a r interval incline matrix.

If $A=[A_L, A_U] \in L_{mn}$ by $\left[C(A_L), C(A_U) \right] = \left[C(A_L A_L^T), C(A_U A_U^T) \right]$, then $\left[A_L A_L^T, A_U A_U^T \right]$ is a ordered interval incline matrix iff $A=[A_L, A_U]$ is a ordered interval incline matrix.

Lemma 3.6

Let $A=[AL, Au] \in L_{mn}$. Formerly the succeeding holds:

(i) $A=[A\iota, Au]$ is regular interval incline matrix $\Leftrightarrow A\iota$ and $Au \in L_{mn}$ are regular.

(ii)
$$\Re(A) = \left[\Re(A_L), \Re(A_U)\right]$$
 and $C(A) = \left[C(A_L), C(A_U)\right]$

Proof

(*i*) Subsequently A=[a_{ijL} , a_{iju}] \in L_{mn}, a few vector [x_L , x_U] \in [\Re (A_L), \Re (A_U)] is of the form [x_L , x_U] =[y_L A_L , y_U A_U] for some [y_L , y_U] \in (IIM) l_D

That is $[x_L, x_U]$ is an interval incline vector with n constituents. Now, Let's calculate $[x_L, x_U] \in [\Re(A_L), \Re(A_U)]$ as follows, $[x_L, x_U]$ is a linear grouping of the rows of $A=[a_{ij}L, a_{ij}U]$.

$$\Rightarrow [x_{L}, x_{U}] = \sum_{i=1}^{m} \alpha_{i} A_{i*}$$

$$= \sum_{i=1}^{m} \alpha_{i} \left[A_{i*L}, A_{i*U} \right]$$

Where $\left[A_{i*L},A_{i*U}\right]$ is the i^{th} row of $\left[a_{ijL},a_{ijU}\right]$ = A.

Equating the j^{th} element on both parties

$$x_j = \sum_{i=1}^m \alpha_i \left[a_{ijL}, a_{ijU} \right]$$

$$= \sum_{i=1}^{m} \left[\alpha_{i} a_{ijL}, \alpha_{i} a_{ijU} \right]$$





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$$= \left[\sum_{i=1}^{m} (\alpha_i a_{ijL}), \sum_{i=1}^{m} (\alpha_i a_{ijU}) \right]$$

 $= [x_{iL}, x_{iU}]$

 x_{jL} is the jth constituent of $x_L \in \Re(A_L)$ and

 x_{ju} is the j th constituent of $xu \in \Re(Au)$.

therefore, $x = [x_L, x_U]$, consequently $\Re(A) = [\Re(A_L), \Re(A_U)]$.

(ii) For A=[a_{ijL} , a_{ijU}], the transpose of A is $A^T = [A^TL, A^Tu] = [a^TijL, a^Tiju]$

By using (i) we get, $[C(A\iota), C(Au)] = [\Re(A^T\iota), \Re(A^Tu)].$

Lemma 3.7

Let $A=[AL, Au] \in L_{mn}$. Subsequently the upcoming is reliable:

- (i) $[\Re(B_L), \Re(B_U)] \subseteq [\Re(A_L), \Re(A_U)] \Leftrightarrow [B_L, B_U] = [X_L A_L, X_U A_U],$ for some $[X_L, X_U] \in (IIM)_m$
- (ii) $[C(B_L), C(B_U)] \subseteq [C(A_L), C(A_U)] \Leftrightarrow [B_L, B_U] = [A_L Y_L, A_U Y_U],$ for some $[Y_L, Y_U] \in (IIM)_n$

Proof

(i) Let A=[AL, Au]=[aijL, aiju] & <math>B=[BL, Bu]=[bijL, biju].

Meanwhile, $[B_L, B_U] = [X_L A_L, X_U A_U]$, for some $[X_L, X_U] \in (IIM)$

Put $X = [X_L, X_U]$,

 $B_L = X_L A_L$ and $B_U = X_U A_U$

Hence by Lemma (2.5), $\Re(B\iota)\subseteq\Re(A\iota)$ and $\Re(B\iota)\subseteq\Re(A\iota)$.

By Lemma (3.4) (ii), $\Re(B) = [\Re(BL), \Re(BU)] \subseteq [\Re(AL), \Re(AU)] = \Re(A)$

Thus, $[\Re(BL), \Re(Bu)] \subseteq [\Re(AL), \Re(Au)]$

Conversely, $[\Re(B\iota), \Re(B\iota)] \subseteq [\Re(A\iota), \Re(A\iota)]$

 $\Rightarrow \Re(B_L) \subseteq \Re(A_L)$ and $\Re(B_U) \subseteq \Re(A_U)$ by Lemma (3.6)(ii)

 $\Rightarrow B_L = Y_L A_L$ and $B_U = Z_U A_U$, by Lemma (2.5)

 $\Rightarrow b_{ijL} = y_L a_{ijL}$ and $b_{iju} = Z_U a_{ijU}$

Then B = [BL, Bu]

- $= [b_{ijL}, b_{ijU}]$
- = $[Y_L a_{ijL}, Z_U a_{ijU}]$
- = $[Y_L, Z_U][a_{ijL}, a_{ijU}]$
- = XA where $X = [Y_L, Z_U] \in L_{mn}$.
- $\therefore B = X A$
- (ii) This may be demonstrated in a manner similar (i) to that of and is so excluded.

Theorem 3.8

Let $P = [P_L, P_U] \in (IIM)_{mn}$. Then P is regular $\Leftrightarrow P_L$ and $P_U \in L_{mn}$ are regular.

Proof

Let $P = [P_L, P_U] \in (IIM)_{mn}$

If p is regular IIM, then there exists $Z \in (IIM)_{mn}$

such that P Z P = P.

Let $Z = [z_L, z_U]$ with $z_L, z_U \in L_{mn}$,





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Then by lemma (3.4) (ii),
[P_L, P_U] [z_L, z_U] [P_L, P_U] = [P_L, P_U]
\Rightarrow[P_L, P_U] [z_L P_L, z_U P_U] = [P_L, P_U]
\Rightarrow [P_L z_L P_L, P_U z_U P_U] = [P_L, P_U]
\Rightarrow P_L z_L P_L = P_L and P_U z_U P_U = P_U
\Rightarrow P_L is regular and P_U is regular in L<sub>mn</sub>
Thus p is regular IIM \Rightarrow P_L and P_U \in L_{mn}.
Conversely, Suppose PL and Pu are regular
Then, P_L z_L P_L = P_L and P_U z_U P_U = P_U for some z_L, z_U \in L_{mn}.
Hence, z \in P \setminus \{1\} and z \in P \cup \{1\}
Since P_L \le P_U, it is possible to choose at least one z_L \in P_L\{1\} and w_U \in P_U\{1\} such that z \le w.
Allow us to establish the interval incline matrix X = [Z, W], Subsequently, according to the lemma (3.4)(ii) we get,
 P \times P = [P_L, P_U] [Z, W] [P_L, P_U]
= [P_L, P_U] [ZP_L, WP_U]
= [P_L Z P_L, P_U W P_U]
= [P_L, P_U]
= P
P X P = P
\Rightarrow P is regular
Both P_L and P_U to be regular is essential.
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Theorem 3.9

Let $A = [AL, Au] \in Lmn$ & $[XL, Xu] \in A\{1\}$, at that moment $[XL, Xu] \in A\{2\}$ iff $[\Re(ALXL), \Re(Au, Xu)] = [\Re(XL), \Re(Xu)]$.

Proof

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In the meantime, A = [A_L, A_U] \& X = [X_L, X_U]
Now, X \in A\{2\} \Rightarrow X \land X = [X_L, X_U][A_L, A_U][X_L, X_U]
                            = [X_L A_L X_L, X_U A_U X_U]
                               X_L A_L X_L = X_L and X_U A_U X_U = X_U
                          X\iota \in A\iota\{2\} \& X\iota \in A\iota\{2\}
                          A \cup \{X \cup \{1\} \& A \cup \{X \cup \{1\}\}\}
\Re(X_L) = \Re(A_L X_L) and \Re(X_U) = \Re(A_U, X_U)
\Rightarrow [\Re(X_L), \Re(X_U)] = [\Re(A_L X_L), \Re(A_U, X_U)]
Conversely, [\Re(A\iota X\iota), \Re(Au, Xu)] = [\Re(X\iota), \Re(Xu)], then by Lemma (2.11),
\Rightarrow [\Re(X_L), \Re(X_U)] \subseteq [\Re(A_L X_L), \Re(A_U, X_U)]
\Rightarrow[ X_L, X_U] = [Y_L A_L X_L, Y_U A_U X_U] for some [ Y_L, Y_U] \in (IIM)_{mn}
\Rightarrow [X_L, X_U] ([A_L X_L, A_U X_U]) = ([X_L A_L X_L, X_U A_U X_U]) ([A_L X_L, A_U X_U])
\Rightarrow ([X_L A_L X_L, X_U A_U X_U]) = [X_L, X_U] ([A_L X_L, A_U X_U]) [A_L, A_U][X_L, X_U]
                              = [X_L, X_U] ([A_L X_L A_L, A_U X_U A_U]) [X_L, X_U]
[X_L, X_U][A_L, A_U][X_L, X_U] = [X_L, X_U][A_L, A_U][X_L, X_U]
                                = [X_L A_L X_L, X_U A_U X_U]
                                = [X_L, X_U] (Definition (3.1))
\therefore X \land X = X
Thus X \in A\{2\}.
In Lemma (3.2) the 1 – inverse of A is necessary which is given in the succeeding.
```





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Example 3.10

Let
$$A = \begin{bmatrix} [0.5, 0.8] & [0.8, 0.8] \\ [0.8, 0.8] & [0.5, 0.5] \end{bmatrix} A = \begin{bmatrix} [0.5, 0.5] & [0.8, 0.8] \\ [0.8, 0.8] & [0.5, 0.5] \end{bmatrix}$$

Then by representation (1) we have,

$$A_{L} = \begin{bmatrix} 0.5 & 0.8 \\ 0.8 & 0.5 \end{bmatrix}, \quad A_{U} = \begin{bmatrix} 0.8 & 0.8 \\ 0.8 & 0.5 \end{bmatrix} \text{ and }$$

$$X_{L} = \begin{bmatrix} 0.8 & 0.5 \\ 0.5 & 0.5 \end{bmatrix}, \quad X_{U} = \begin{bmatrix} 0.8 & 0.8 \\ 0.5 & 0.8 \end{bmatrix}$$

$$A_L X_L A_L = \begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0.8 \end{bmatrix} \neq A_L \text{ implies } X_L \notin A_L \{1\} \text{ and }$$

$$A_{U}X_{U}A_{U} = \begin{bmatrix} 0.8 & 0.8 \\ 0.8 & 0.8 \end{bmatrix} \neq A_{U} \text{ implies } X_{U} \notin A_{U} \{1\}$$

$$A_L X_L = \begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0.8 \end{bmatrix}$$
 and $A_U X_U = \begin{bmatrix} 0.8 & 0.8 \\ 0.8 & 0.8 \end{bmatrix}$

But
$$X_L A_L X_L = \begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0.8 \end{bmatrix} \neq X_L$$
 and $X_U A_U X_U = \begin{bmatrix} 0.8 & 0.8 \\ 0.8 & 0.8 \end{bmatrix} \neq X_U$

Hence $X_L \notin A_L\{2\}$ and $X_U \notin A_U\{2\}$

$$\begin{bmatrix} A_L X_L A_L , A_U X_U A_U \end{bmatrix} \neq \begin{bmatrix} A_L, A_U \end{bmatrix}$$

Therefore,
$$\begin{bmatrix} X_L, X_U \end{bmatrix} \neq A \{2\}$$
, Here $\Re(X_L) = \Re(A_L X_L)$ and

$$\Re(X_U) = \Re(A_U X_U)$$

Therefore by Lemma (3.6),

$$\left[\Re(X_{L}),\Re(X_{U})\right] = \left[\Re(A_{L}X_{L}),\Re(A_{U}X_{U})\right] \text{ but}$$

$$\left[X_{L}A_{L}X_{L},X_{U}A_{U}X_{U}\right] \neq \left[X_{L},X_{U}\right]$$

Hence $[X_L, X_U] \notin A\{2\}$

Theorem 3.11

For $A=[A\iota, Au] \in \mathbb{L}_{mn}$, A has a $\{1, 3\}$ inverse iff $[A^T\iota A\iota, A^TuAu]$ is a regular IIM and $\left[\Re\left(A_L^TA_L\right), \Re\left(A_U^TA_U\right)\right] = \left[\Re\left(A_L\right), \Re\left(A_U\right)\right]$.

Proof

Since [AL, Au] is regular, by Lemma (3.6), AL & Au are regular. Let [AL, Au] has $\{1, 3\}$ inverse [XL, Xu] (say) AL has a $\{1, 3\}$ inverse XL and AU has $\{1, 3\}$ inverse XL and AU has $\{1, 3\}$ inverse XL and AU has $\{1, 3\}$ inverse XL and AU has $\{1, 3\}$ inverse XL and AU has $\{1, 3\}$ inverse $\{1,$

- $\Rightarrow A^{T_L} (A_L X_L A_L) = A^{T_L} A_L$
- $\Rightarrow (A^{T_L} A_L X_L) A_L = A^{T_L} A_L$
- $\Rightarrow \Re (A^{T_L} A_L) \subseteq \Re (A_L)$ (by Lemma (2.5))



 $[(A_L Y_L)^T, [(A_U Y_U)^T] = [A_L Y_L, A_U Y_U]$



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correspondingly, \Re(A^Tu Au) \subseteq \Re(Au)
as a result,
[\Re(A^TLAL), \Re(A^TuAu)] \subseteq [\Re(AL), \Re(Au)]
             (A_L X_L)^T A_L = A_L X_L A_L
                          \Rightarrow X^T_L A^T_L A_L = A_L
                          \Rightarrow X^{T_L} (A^{T_L} A_L) = A_L
                        \Rightarrow \Re(A_L) \subseteq \Re(A^T_L A_L) (by Lemma (2.5))
correspondingly, \Re(Au) \subseteq \Re(A^Tu Au)
Therefore, [\Re(AL), \Re(AU)] \subseteq [\Re(A^TL AL), \Re(A^TU AU)]
Thus, [\Re(AL), \Re(AU)] = [\Re(A^TLAL), \Re(A^TUAU)]
Since, [X_L, X_U] \in A\{1\}, [\Re(A_L), \Re(A_U)] = [\Re(X_L A_L), \Re(X_U A_U)]
Hence, [\Re(A^TLAL), \Re(A^TUAU)] = [\Re(AL), \Re(AU)]
                                        = [\Re(X_L A_L), \Re(X_U A_U)]
Since [\Re(A^T L A L), \Re(A^T U A U)] \supseteq [\Re(X L A L), \Re(X U A U)],
                                                                                   by Lemma (3.7)
    \implies Let Y = [Y_L, Y_U], then Y A^T A = X A
                    \Rightarrow A^{T_L} A_L (Y_L A^{T_L} A_L) = A^{T_L} A_L (X_L A_L)
                     \Rightarrow (A^{T_L} A_L) Y_L (A^{T_L} A_L) = A^{T_L} (A_L X_L A_L)
                      = A^T_L A_L
Similarly, A^T u A u (Y u A^T u A u) = A^T u A u, We have,
\left[A^{T_{L}}A_{L}\left(Y_{L}A^{T_{L}}A_{L}\right),\ A^{T}uAu\left(Y_{U}A^{T}uAu\right)\right]=\left[A^{T_{L}}A_{L},A^{T}uAu\right]
Thus [A^{T_L}A_L, A^{T_U}A_U] is a regular.
Conversely, Let [A^T_L A_L, A^T_U A_U] is a regular interval incline matrix and [\Re(A_L), \Re(A_U)] \subseteq [\Re(A^T_L A_L), \Re(A^T_U A_U)]
By Lemma (3.5), [A_L, A_U] is a regular IIM. Let us take, [Y_L, Y_U] = [(A^T_L)^- A^T_L, (A^T_U)^- A^T_U] \in L_{mn}, It is said that [Y_L, Y_U] \in L_{mn}
A\{1,3\}. [\Re(A\iota),\Re(Au)] = [\Re(A^T\iota A\iota),\Re(A^Tu Au)] and [A^T\iota A\iota,A^Tu Au] is regular. by Lemma (3.5),
[A_L, A_U] = [A_L (A^T_L A_L)^- A^T_L A_L, A_U (A^T_U A_U)^- A^T_U A_U]
          = [A_L Y_L A_L, A_U Y_U A_U]
           = AYA, Y \in A\{1\}. and in the meantime [\Re(A\iota), \Re(Au)] = [\Re(A^T\iota A\iota), \Re(A^Tu Au)]
[A_L, A_U] = [X_L A^T_L A_L, X_U A^T_U A_U]
  A_L = X_L A^T_L A_L and A_U = X_U A^T_U A_U
Let Y = [Y_L, Y_U], formerly A_L Y_L = X_L A^T_L A_L (A^T_L A_L)^- A^T_L
                                          = X_L A^{T_L} A_L (A^{T_L} A_L)^- A^{T_L} A_L X^{T_L}
                                         = X_L (A^T_L A_L) (A^T_L A_L)^- (A^T_L A_L) X^T_L
                                            = X_L (A^T_L A_L X^T_L)
                                            = X_L A^{T_L}
Similarly, AuYu = X_U A^Tu
[A_L Y_L, A_U Y_U] = [X_L A^T_L, X_U A^T_U]
\Rightarrow (A_L A_L) = (X_L A_L)^T
= A_L X^{T_L}
= X_L A^{T_L} A_L X^{T_L}
= X_L A^{T_L}
= A_L Y_L
Similarly, \Rightarrow (Au A^Tu) = (Xu A^Tu) = Au Yu
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 $[Y_L,Y_U]\in A\{1,3\}.$

Since $[\Re(A\iota), \Re(Au)] = [\Re(A^T\iota A\iota), \Re(A^Tu Au)]$ By Lemma (3.6) and regularity of $[A^T\iota A\iota, A^Tu A\iota]$ we get, $[A\iota, Au] = [A\iota (A^T\iota A\iota) - (A^T\iota A\iota), A\iota (A^T\iota A\iota) - (A^T\iota A\iota)]$ $= [A_LY_LA_L, A_UY_UA_U], [Y_L, Y_U] \in A\{1\}$ Thus $[A\iota, Au]$ has $A\{1, 3\}$ inverse.

Theorem 3.12

Let $A = [AL, Au] \in L_{mn}$, [AL, Au] has $\{1, 4\}$ inverse iff $[ALA^TL, AuA^Tu]$ is regular and $[C(A^TLAL), C(A^TuAu)] = [C(AL), C(Au)]$.

Proof

This may be shown using the similar approach comparable to Theorem (3.11).

Corollary 3.13

Let $A = [A_L, A_U] \in L_{mn}$, be a regular IIM with $[A_L A^T_L, A_U A^T_U]$ is regular IIM and $\left[\Re\left(A_L^T A_L\right), \Re\left(A_U^T A_U\right)\right] = \left[\Re\left(A_L\right), \Re\left(A_U\right)\right]$, then

 $[Y_L, Y_U] = [(A^T_L A_L)^- A^T_L, (A^T_U A_U)^- A^T_U] \in A\{1, 2, 3\}.$

Proof

[Y_L, Y_U] ∈ A{1, 3} monitora as of Theorem (3.11), It is sufficient prove $Y = [Y_L, Y_U] \in A$ {2} so it is $Y_L A_L Y_L = Y_L$ and $Y_U A_U Y_U = Y_U$ Now, $Y_L A_L Y_L = Y_L (X^T_L A_L) (A^T_L A_L)^- A^T_L$ $= Y_L X^T_L (A^T_L A_L) (A^T_L A_L)^- (A^T_L A_L X_L)$ $= Y_L X^T_L (A^T_L A_L) (A^T_L A_L)^- (A^T_L A_L) X_L$ $= Y_L X^T_L A^T_L A_L X_L$ $= Y_L A_L X_L$ $= [(A^T_L A_L)^- A^T_L] A_L X_L$ $= (A^T_L A_L)^- (A^T_L A_L X_L)$ $= (A^T_L A_L)^- A^T_L$ ∴ $Y_L A_L Y_L = Y_L$

Similarly, Yu Au Yu = Yu. $[Y_L A_L Y_L, Yu Au Yu] = [Y_L, Yu]$ Thus $[Y_L, Yu] \in A\{1, 2, 3\}$.

Theorem 3.14

Let $[A_L, A_U] \in (IIM)_{mn}$ be a r IIM with $[A_L, A^T_L, A_U, A^T_U]$ is r IIM and $\left[\Re\left(A_L^T\right), \Re\left(A_U^T\right)\right] = \left[\Re\left(A_LA_L^T\right), \Re\left(A_UA_U^T\right)\right]$, then $[Z_L, Z_U] = [A^T_L, (A^T_L, A_L)^-, A^T_U, (A^T_U, A_U)^-A^T_U] \in A[1, 2, 4].$

Proof:

This Could be shown using the identical methodology comparable to theorem (3.7) and Corollary (3.8), so it is eliminated.





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RESEARCH ARTICLE

Deepfake Face Classification using Deep learning

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ABSTRACT

Deepfake face classification is a crucial technology for identifying manipulated images in which a person's face has been altered or replaced using artificial intelligence. In simple terms, it helps us spot fake pictures where someone's appearance has been changed. This technology uses advanced algorithms to analyse and recognize the differences between real and altered faces. Detecting deepfakes is essential for maintaining trust and authenticity in the digital world. Finding altered faces in deepfake images is one of the most critical issues. In this work, this system offers a reliable and efficient method for deepfake face classification with CNNs. This study focuses on the classification of manipulated facial images using CNNs, which are highly skilled at feature extraction and pattern recognition. This technology protects the truth and authenticity of digital media by recognizing and detecting these deepfake faces. To identify deepfakes is essential in a world where fake data can have far-reaching effects. It serves as vital for stopping the spreading of incorrect or misleading information, especially on social media and in the news. Beyond this, deepfake face classification protects people from malicious impersonation for identity theft or fraud, thereby enhancing security and privacy.

Keywords: Deep learning, CNN, Spoof net model, Sequential layer, DenseNet121 layer, Batch Normalization, Con2D, MaxPool2D.





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INTRODUCTION

People's trustworthiness with digital media content has been reduced by the development of Deepfakes since they are unable to trust the images they are seeing. If deep learning is not implemented, research on the classification or identification of phony or manipulated media is regarded as conventional research. Forensics experts find it more challenging to detect forgeries since deep learning is used to build Deep Fakes and web-based applications are used to generate Deepfakes fast. For this reason, scientists are creating a DNN model to identify Deepfakes. Essentially, trials are used to evaluate the model's performance after it has been trained using Deepfake datasets. Datasets and production techniques used for Deepfakes in order to identify them. Studies on the creation and classification of Deepfake in images have recently been published. To present the Deepfake tools, which are used to alter many features of photographs. Deepfake tools for adjusting various parts of pictures. Deepfake datasets along with some ordinary datasets for forensic analysis. To examine a few of the most recent Deepfake classification methods for application in pictures. The majority of face decryption techniques use deep learning, particularly convolutional neural networks (CNNs), such Mesho net, VGG19, Res Net, and Meso Inception, which were initially designed for the purpose of the identifying the deepfake images. In order to extract content elements from an image in a hierarchical manner, these models use several stacked layers.

First, they extract low-level features like edges, mesh patterns, and text, and then they combine these data to identify and categorize object-specific features. Therefore, all layers for false classification-aside from the classification portion-are borrowed for transfer learning. Among CNNs for fake face classification, Spoofnet demonstrated the strongest performance. Conventional garbage bins solely collect waste, and sanitation workers must carry out manual inspections to assess the trash level in the bins. This approach is not efficient for routine waste disposal inspections. Moreover, due to the frequent filling of the containers, disease-causing organisms and insects tend to breed on them (Noiki et al. 2021). Therefore, designing intelligent garbage bin monitoring systems to manage garbage is essential in constructing smart cities. Garbage classification is strongly recommended for municipal solid waste managing and using robots can substantially enhance the efficiency of garbage classification. However, robots require advanced visual and operational skills to function in highly heterogeneous, complex, and unpredictable industrial environments for garbage. Sensor-based waste monitoring is a technology that utilizes sensors to track the amount of waste generated, identify the sources of waste, and measure the effectiveness of waste management strategies in a specific area. Wireless sensor network is a network composed of many self-organized wireless sensors installed in the network to monitor the physical or environmental parameters of the system (Gurram et al. 2022). As illustrated in Fig. 2, a typical wireless sensor network architecture for solid waste treatment systems includes various sensors, such as temperature, humidity, odor, infrared, gas, and sound sensors. Increase waste management efficacy.

LITERATURE SURVEY

Driven by advanced algorithms and neural networks, deepfake technology makes it possible to create images that are incredibly realistic yet are completely manufactured, especially when it comes to human faces. Because deepfakes are frequently exploited for harmful, misleading, or privacy-invading objectives, there is an urgent need to develop effective classification and prevention measures. In previous work provides an extensive overview of face manipulation techniques, including deepfakes, and explores the state-of-the-art methods for detecting these manipulations [1]. The Face Forensics++ dataset and presents a detailed analysis of deepfake classification using CNNs and other methods [2]. This work explores a unique approach to deepfake classification by analysing discrepancies between speech and lip-sync in video content [3]. Previous work focuses on face anti-spoofing, which is related to deepfake classification, and discusses CNN-based models for the task [4]. This system introduces MesoNet, a compact neural network for detecting facial video forgeries, including deepfakes [5]. This system explores the use of Capsule Networks for detecting forged images and videos, including deepfakes [6]. This work discusses the classification of spoofing attacks, which can be relevant to deepfake classification,





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especially when 3D masks are involved [7]. This system, focused face presentation attack classification, which is relevant for detecting attempts to spoof facial recognition systems.

PROPOSED METHODOLOGY

The objective of our system is to address this growing concern by developing a robust and efficient deepfake face classification system that leverages the power of Convolutional Neural Networks (CNNs). This system aims to contribute to the ongoing efforts to combat the proliferation of deepfake content and protect the integrity of digital media. Classification of deepfake content is paramount in ensuring the credibility and authenticity of digital media. By identifying manipulated faces in images, we can mitigate the harmful effects of deepfakes, protect individuals' privacy, and maintain the integrity of online information and visual content. Convolutional Neural Networks (CNNs) have proven to be highly effective in image classification tasks, making them a promising choice for deepfake face classification. With its ability to manipulate facial imagery in a highly convincing way, deepfake technology has opened up new possibilities in the digital world. Deepfakes, which can perfectly blend the face of one person onto the face of another, have raised a lot of concerns because to its potential for identity theft, misinformation, and privacy violation. Deepfake classification is a rapidly evolving field as a response to this growing threat. In this paper, will thorough look at deepfake face classification using Convolutional Neural Networks (CNNs) and the cutting-edge "Spoof Net" model, a sophisticated neural network architecture designed for this particular deep learning task. In deepfake face classification, Convolutional Neural Networks (CNNs) are commonly used for their effectiveness in image analysis and feature extraction. The architecture of a CNN for deepfake face classification typically consists of several layers designed to process facial images and make predictions about whether the face is genuine or a deepfake. DenseNet121 layer is a deep learning architecture used for deepfake face image classification. It is known for its dense connectivity, where each layer has access to all previous layers' features. This enables it to efficiently capture both fine-grained details and high-level features, making it effective in distinguishing authentic faces from manipulated ones.

EXPERIMENTS AND RESULTS

The primary objective of this module is to implement a binary classification system using a pre-trained Keras model. The module serves as a key building block in a broader framework for solving problems that require the classification of data into one of two distinct categories. The module aims to make efficient use of a pre-trained Keras model, which is a neural network that has been previously trained on a large dataset to extract meaningful features from input data. By loading and applying this pre-trained model, the module capitalizes on the knowledge and representations learned during its training. The primary task is binary classification, where the input data is categorized into one of two classes. This could be, for example, distinguishing between genuine and fraudulent transactions, identifying objects in images, or classifying emails as spam or not. The module's core function is to generate predictions for a test dataset using the pre-trained model. The predictions are typically in the form of continuous probability scores, reflecting the likelihood of belonging to one of the two classes. To make the predictions more actionable and interpretable, the module applies a thresholding technique. Predictions are transformed into binary labels, where values greater than the threshold are assigned to one class, and values less than or equal to the threshold are assigned to the other class. The module provides insights into the binary labels produced by the model. This allows for evaluating the model's accuracy and effectiveness in distinguishing between the two classes. The binary labels generated by this module are crucial for subsequent analysis and decision-making. They can be used in downstream tasks such as accuracy assessment, model performance evaluation, or to guide decision processes. The module's objective is not limited to a specific domain but is applicable to a wide range of binary classification problems. Whether it's identifying fraudulent activities, classifying images, or making yes/no decisions, the module can be incorporated into various applications. To collect a deepfake face classification dataset, source images from platforms like social media, respect privacy and rights, label them as real or deepfake, and split for training and testing. Ensure ethical handling and update the dataset for ongoing accuracy.





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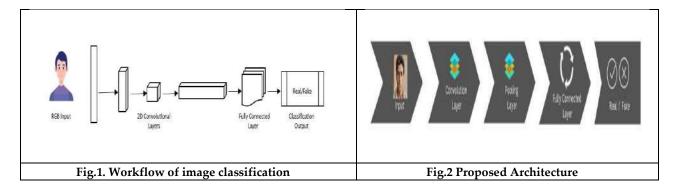
Data preprocessing is responsible for ingesting and preprocessing the input data, ensuring uniformity in terms of image resolution, alignment, and quality. It involves tasks such as data normalization, resizing, and data augmentation to enhance the robustness of the model.

CONCLUSIONS

Identifying deepfake photos may be effectively done with the help of the Convolutional Neural Network (CNN) and the "Sequential" model. People can be tricked by deepfakes, which are fake images or movies made with cutting-edge technology. With great precision, this system assists us in identifying these fakes. Our data is carefully chosen and prepared in order for this system to function. Then, by providing it with several instances, we teach the algorithm to identify deepfakes. Ongoing performance checks to ensure that it remains current and we test it to ensure that it can distinguish between genuine and fake photos. Along with protecting people's privacy and adhering to usage guidelines, this technology also assists us in identifying phony photographs.

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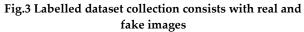






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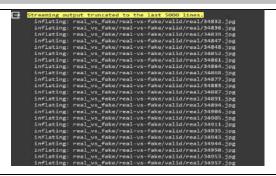


Fig.4 Data Testing and Validation



Fig.5 Sample images

